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THE WEST AFRICAN CABLE.

THE debate in the House of Commons last week, on the subject of the West African Cable, must have left on the minds of the vast majority of those who read the reports something akin to astonishment that charges made with such directness and apparent sincerity as those urged by Mr. Henniker Heaton against the contracting parties in the laying of the cable under discussion, should be allowed to pass with so slight an explanation as that vouchsafed by the past and present Secretary of the Treasury. Either the contract was or was not a dishonest one, and in either case the unequivocal language used by Mr. Henniker Heaton demanded more attention than it appears to have received. Mr. Heaton may possibly be to blame for not having communicated the evidence which he claimed to possess as to the irregularities he alleged had taken place in the conduct of the affair; and indeed it seems strange that he should have withheld mention of it until so late an hour in the proceedings, when the final stage of the contract was on the point of being passed. We can scarcely wonder that the House refused, on the slight evidence before it, to withhold its sanction to a contract which was supported so strongly by the representatives of three Governments; but it will be strange, indeed, if we have heard the last of this matter. We do not imagine for a moment that it was on the part of the Government officials that Mr. Henniker Heaton alleged or suspected any grave departure from rectitude in the conduct of the matter, but the character of persons holding semi-public positions was gravely and directly assailed during the course of the debate, and we can scarcely believe that those persons, if they have any regard, as they assuredly must have, for their reputation before the world, will allow the matter to be quietly dropped. We have in previous numbers of this journal called attention to circumstances which appeared to us in the light of peculiarities in connection with the laying of this cable, and now more than ever an explanation seems to be demanded of the whole history of the enterprise. No one is more capable of giving such an explanation than Mr. John Pender, but had not his name been mentioned in such unpleasant terms in the House of Commons, he would have been the very last person to whom we should have looked for it. He must now, however, feel called upon to say something.

West African Telegraph Company, Limited.—In our notice of this company in "Official Returns" last week, it was erroneously stated that the capital of the company was reduced to £40,000 in £10 shares. The figures should have been £400,000, divided into 40,000 shares of £10 each.

AMERICAN TELEPHONE PATENTS.

A CORRESPONDENT has referred in his letter, in another part of this issue, to the published opinions respecting the case which is now agitating telephonic and legal circles in America of a prominent American, whose letter in a New York paper our correspondent has forwarded us. The person referred to is Mr. George Ticknor Curtis, who consumes two closely-printed columns in explaining the circumstances attending the bringing of suit by Government for the vacation of the Bell patents, with the view of showing that the conduct of the legal officers of the Government has been entirely blameless. In this endeavour he seems to succeed, for he points out that Attorney-General Garland was in entire ignorance of what was done in his absence by the Solicitor-General, Mr. Goode; that Mr. Goode, when he gave instructions in the first place for the bringing of the suit, had no knowledge of the fact that the Attorney-General was interested in the matter, and that the action of the President in directing the abandonment of the first suit and the enquiry before the Secretary of the Interior was solely caused by his belief that the matter was of sufficient importance to bring it into compliance with a rule of administration, that when anything out of the common course was to be done by the Department of Justice, the head of the other Department primarily concerned should first act upon it. Then he says:—"However problematical it may be, whether the United States can, under existing laws, maintain any suit to repeal or vacate a patent for a useful invention on any ground that could be pleaded by an individual when sued for infringing that patent—and to me it seems very doubtful—yet I can well understand how Mr. Lamar came to authorise or advise such a suit in reference to the Bell patent. In the first place, there are a certain number of precedents for it; and although those precedents do not exactly fit the present case, they are sufficient to warrant the Executive in all executive action that has been taken, namely, to refer it to the courts, and ultimately to the Supreme Court, to determine, first, whether the United States can maintain the suit, and, secondly, whether, supposing the suit to be well brought, the Bell patent is valid or invalid." In conclusion we may say that Mr. Curtis has no high opinion of the value of the stock held by Mr. Garland in the Pan-Electric Company.

Railway Carriage Lighting.—"Dogberry," writing in Wednesday's *City Press*, says:—"I am told that on the Great Northern Railway some half-a-dozen different lights are used—all of them bad, and some simply intolerable. The change from a Northern to a North London carriage, which is invariably lighted with gas, is remarkable in the extreme. Passengers have been complaining of the "Northern lights" for years. It is hardly creditable to a great railway company that a nuisance like this should be so long suffered to continue. I shall be glad if any correspondent can give me some "light" on the subject of railway illumination." Why does not "Dogberry" "interview" the Railway Electric Lighting Company, Limited?

FALL OF ELECTROMOTIVE FORCE WITH DISCHARGE OF A BATTERY.

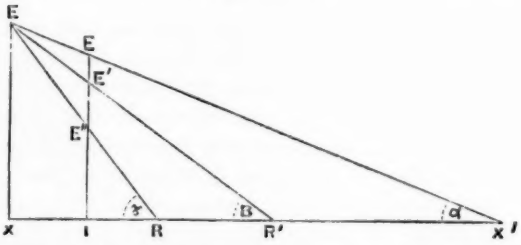
DR. LODGE, in a recent number of *The Engineer*, writes Dr. Paget Higgs, pointed out a difficulty that beset the student in experiments with batteries, and explained one of those practical phenomena of which the reason why is not always apparent *prima facie*. I would like to add some remarks about the discharge of batteries, with regard to a stumbling block that I have found a good many tripping over.

It is customary to give the electromotive force of a battery as obtained on open circuit. This for comparison is sometimes serviceable, but practically the figures have little value. What the practician (to borrow a word from our French neighbours) requires to know is the electromotive force when the battery is producing current. This is frequently a very different result, as many a poor amateur has found to his cost. It is not at all an unusual thing in an amateur's calculations for him to take the electromotive force on open circuit as the working electromotive force, and then for him to find that his incandescent lamps (an amateur generally fails here) are only red hot instead of white hot. And I am sorry to have to say it, but not always is this oversight confined to the amateur.

The best batteries are considered impolarisable (another word from the French, but perhaps we have left them too long in possession of the field), that is, the hydrogen evolved at the positive electrode is supposed quite consumed in the reduction of a metal, or by its oxidation or chlorination. If this consumption is not perfect, an unknown factor is introduced into our problem, and one that no economist will allow. However, all batteries *are* polarisable at a certain limit, where the production of hydrogen exceeds either the rate of contact of the consuming material, or the capacity of that material; in the latter case the battery is said to be exhausted; in the former a larger cell generally avoids the difficulty, or a larger surface of positive electrode. Yet this point is sadly neglected in nearly all battery construction. There is scarcely an ordinary form of battery in the market in which the positive electrode and amount of hydrogen-consuming material are not too small, with relation to the surface of zinc, to produce the best results. This, then, is the constructive difficulty, that does not, however, beset the amateur unless he builds his own battery; it is, however, a trade oversight.

Supposing a properly constructed battery, there is yet another obstacle, and this is the one to which I refer as commonly neglected—the unavoidable and inherent internal resistance. Him who doubts my statement as to this neglect I would refer to the columns of any of our technical papers, where teem inquiries as to failures to light incandescent lamps with such batteries as the Leclanché, intended for a totally different work. Even when, too, the amount of this resistance is understood by the student to depend upon size and upon distance apart of the electrodes, I have known failure to be incurred in the attempt at reduction of resistance, by bringing the electrodes so close together as to prevent circulation of a sufficient amount of the hydrogen-consuming material. With accumulators it is not at all uncommon to have the plates too close together to admit of the bulk of sulphuric acid necessary for the proper formation of sulphate: the space having been reduced with the single view of reducing the internal resistance of the cell. But the internal resistance of a battery varies also with the liquid employed, and with so many other causes as to prevent generalisation. What has to be now attempted is the explanation of the effect of this resistance.

Any explanation that can be referred to a geometrical consideration has an advantage in being apparent to the physical eye, as well as to the mind's eye, to which alone figures and symbols appeal. Therefore let X, I in the horizontal line, X, X^1, represent the internal resistance of the battery, and let I, X^1 be the resistance of the voltmeter. The vertical line, E, will be taken to represent the internal electromotive force of the battery, and then the line E^1 at the other extremity of X, I will be the electromotive force at the terminals of the battery when only the voltmeter is in circuit. Let us now set the battery to work on a resistance represented by I, R, and we see that the line joining E and R—corresponding to the line joining E, X^1 when only the voltmeter was in circuit—now makes a greater angle with the horizontal line of resistance, and cuts the line giving the electromotive force at the terminals at E^{11}, which is now the electromotive force



appearing on the voltmeter or, if I, R represent lamp resistance, at the terminals of the lamps. If I, R^1 be the lamp resistance giving the electromotive force, E_1, proper to the requisite brightness of the lamps, then, although we have a greater angle, γ, than at β (B)—the currents are proportional to the tangents of these angles, not to the angles themselves—and a greater current flowing out with the lesser electromotive force, E^{11}, the lamps—in parallel—have not each the electromotive E_1 at their terminals necessary to drive the proper current through them. With the highest electromotive force we have the lowest current, tan α.

This little diagram based on the simplest reasoning shows at once the fallacy of giving the electromotive force without the corresponding current.

ELECTRIC LIGHT REGULATION.

ON Tuesday and Wednesday last week a number of gentlemen interested in electric lighting were, by the kindness of Messrs. Robey & Co., of Lincoln, privileged to inspect the installation which was completed some months since at Muncaster Castle, the residence of Lord Muncaster, Lord Lieutenant of Cumberland. The work was carried out by Messrs. J. Edmundson & Co., of Westminster and Dublin, and has been in successful operation during the winter. The current is generated by a pair of Elwell-Parker dynamos driven by a Robey semi-portable steam engine of 16 H.P. nominal with all the latest improvements, a type of engine admirably adapted for general electric lighting purposes. This engine is fitted with one of Mr. Richardson's electric governors constructed with an improvement suggested by Mr. R. H. C. Nevile, by which the E.M.F. is kept constant under any variation of load or of boiler pressure. The regulator consists of a double solenoid within which works a double core with crosspiece at the bottom to which is linked the long arm of a lever of which the short arm presses downward upon the spindle of a valve controlling the admission of the steam to the steam chest. For incandescent lighting in parallel the wire on the bobbins is placed in shunt circuit between the main leads, and the size of wire used adjusted according to the E.M.F. which it is desired to maintain between the mains, so that when the E.M.F. is at the right point, the cores are suspended within the solenoids by their attraction. The resistance of the solenoids being fixed, any increase in E.M.F. causes an increased current to flow through them, whereby the cores are immediately attracted with an increased force, and are caused to move upwards, thereby so acting upon the lever as to close the valve until the E.M.F has been brought down again to its normal amount. There is also an attachment by which any accidental severance of the main lead would cause the stoppage of the engine. Under every kind of trial

this regulator worked with the most satisfactory promptness and efficiency.

Both the steam pressure and the load were varied in every possible way, the regulator never showing a variation of more than 2 or 3 volts in the E.M.F., nor in the case of the most sudden changes, such as switching on or off the whole of the lights, taking more than 3 or 4 seconds to right itself; and this without the least tendency to overrun or "hunt." The great advantage gained in the shape of lengthened life of lamps is of itself sufficient to render the use of such a regulator a decided economy in the case of every installation on the incandescence system.

In a paper read by Mr. Richardson at the Lincoln meeting of the Institute of Mechanical Engineers, he pointed out the advantage of using such a regulator in connection with a compound engine in the following words :—"A compound engine may be a very economical motor when developing, say, 50 H.P. at 150 revs. per minute, while it would be exceedingly wasteful if called upon to give out only 5 H.P. at the same speed. But if the speed can be reduced in proportion to the load, bringing it down to 15 revs. per minute, the pressure and distribution of steam would remain the same; and each stroke of the engine would be delivered with the same economy as when developing the higher power, with the further good result of saving nine-tenths of the friction. The electric regulator enables this desirable result to be obtained."

The total number of lamps, which are of the Edison-Swan 16 C.P. (100 volts) type, is 180, and they are distributed throughout the house, stables and offices. Many of them are fitted into antique sconces and standards, with which they harmonise better than might at first be expected. Some lights in the corridors and on the staircase in Moorish pendants look remarkably well. In the library Messrs. Edmundson and Co. have put in an elegant electrolier of their own make, and in the billiard room have adopted a very effective arrangement of the light. By the use of accumulators the working of the machinery is dispensed with on Sundays, and the regulation in every way rendered as perfect as possible. It is interesting to know that Messrs. Edmundson & Co. find plenty to do in the special branch of electric work to which they devote themselves, namely, the lighting of country mansions. Already they have set on foot more than a score of such installations in various parts of the kingdom, and certainly the perfection of such a system as is now at work at Muncaster Castle should be sufficient encouragement to anyone possessing the means and the desire to give electric lighting a fair trial.

GENERATORS AND MOTORS.

CAPTAIN E. DUBOIS, writing under date of February 12th to the Editor of our contemporary *La Lumière Electrique*, made the following comments upon Mr. Mordey's recent paper :—

I beg to submit to your notice the following reflections which occurred to me upon reading the analysis of an article by Mr. W. Mordey on the subject of the dynamo considered as a generator and as a motor.

Mr. Mordey thinks rightly that in a motor the armature should have no polar action, its core having no other function than to act as a conductor of the lines of force, and that the whole action of the motor is due to the current of the armature cutting at right angles the lines of force of the field. This is the opinion of all good writers; and M. Marcel Deprez, in the remarkable articles that he has written on different occasions for *La Lumière Electrique*, has always maintained implicitly that the couple communicating with a ring traversed by a current situated in a magnetic field, resulted from the dynamic actions exercised on the single wire of the ring. He has, besides, given a demonstration of this fact in the number for October 31st, 1882, page 207.

In explanation of the fact that the coefficient of transformation in a dynamo is higher when acting as generator than when acting as receiver, Mr. Mordey remarks that the parasitic currents in the core of the induced part are of the same nature as the principal current in the first case, that they are of the opposite nature in the second, and that, consequently, in a generator these two kinds of currents, according to the laws of induction, act so as to become weaker, whereas, in a receiver, they tend to grow stronger.

Therefore, in this latter case, the loss of energy arising from the heating of the core must be greater.

I thought in a matter of such importance it would be well to make sure of the truth of this theory, and I therefore ascertained in the following manner the way in which parasitic currents act.

In a generator, when the speed is increased progressively, the current increases with it; consequently, it induces in the iron of the ring a current in opposition to the parasitic current which tends to diminish the increase of this current consequent on the acceleration of speed; when the speed arrives at a certain value, the parasitic current has a certain intensity, and it will easily be seen that it retains this intensity as long as the speed remains constant.

In fact, in this case, the contrary inductive action of the principal current ceasing, the intensity of the parasitic current would increase since the speed has been increasing; but if this current increased, it would induce an opposing current which would diminish the current of the ring, and consequently the speed of the ring would go on increasing; therefore, in order that this speed may remain constant, it is necessary that the parasitic current should keep the intensity that it had at the moment the speed became uniform. Thus, in a generator, the intensity of the parasitic current increases very slightly with the speed. This is not the case with a receiver. For with the increase in intensity of circulation, the speed increases; and, on the one hand, the current, increasing, gives rise to a current in the core of the induced part which is of the same nature as the parasitic currents, so that their intensity is increased; and this intensity is still further increased by the acceleration of speed.

Thus the intensity of these parasitic currents increases considerably with the speed.

The above reasoning will show that when the speed becomes constant, this intensity remains fixed at the same value as when the speed became uniform.

From the above remarks we may see how important it is to diminish the intensity of the parasitic currents, especially in the case of a receiver. This is effected, as we know, by dividing the iron of the induced part by several partitions of insulating material perpendicular to the axis of rotation and by carefully insulating these different subdivisions; thus the formation of parasitic currents in the entire mass of the induced part is avoided and the loss of energy due to the heating of the masses of iron is lessened.

When the mass of the induced part is not divided, the loss of energy $= \Sigma\, E\, I$, E being the electromotive force of one of these currents and I its intensity.

If we have n insulating partitions, the electromotive force of induction on the edge of one of these partitions will be $\frac{E}{n}$ and the intensity of the current resulting from it $\frac{I}{n^2}$, since the resistance of one subdivision is n times greater; and the loss of energy will then be $\Sigma \frac{E}{n} \times \frac{I}{n^2} = \frac{\Sigma\, E\, I}{n^3}$; *i.e.*, n^3 times less.

In one trial made with a receiver intended for the Creil experiments, M. Marcel Deprez found that the loss of energy corresponding to the parasitic currents amounted to 14 H.P. at a speed of 100 revolutions of the ring.

The mass of iron of the ring was well divided, but bolts insufficiently insulated connected the different circles forming the induced part and established amongst them a communication which diminished the

resistance of the metal of the ring and increased considerably the intensity of the parasitic currents.

The rings having been taken off and the various parts of the divided core carefully insulated, the coefficient of transformation returned to a value admissible when compared with that attained in a generator.

This fact shows of what great importance it is to divide the mass of the induced part in a motor and to insulate carefully the different parts, so as to diminish as much as possible the loss of energy arising from their being heated. I thought that, the subject being a most important one, the above remarks might be of some interest.

HOW TO WIND MAGNETS FOR SHUNT, SERIES AND COMPOUND MACHINES.

I.

IN building dynamos of the ordinary types, the first thing to do, writes Carl Hering in the *Electrical World*, is to calculate the diameter of the wire on the armature from the current to be delivered, then determine the number of turns, the diameter and length of the armature, as nearly as one can, from the electromotive force required; construct the frame by comparison with other finished machines, and determine upon the maximum speed allowable, which latter depends upon the diameter and weight of armature, length of shaft between bearings, rigidity of the frame, &c. Having done this, it is then necessary to determine the winding of the magnets, in order that, with this speed and armature, the machine may give its required electromotive force, or its constant potential, as in the case of compound machines. A description of a method of doing the latter without the factor of uncertainty, so often included, is the object of this article.

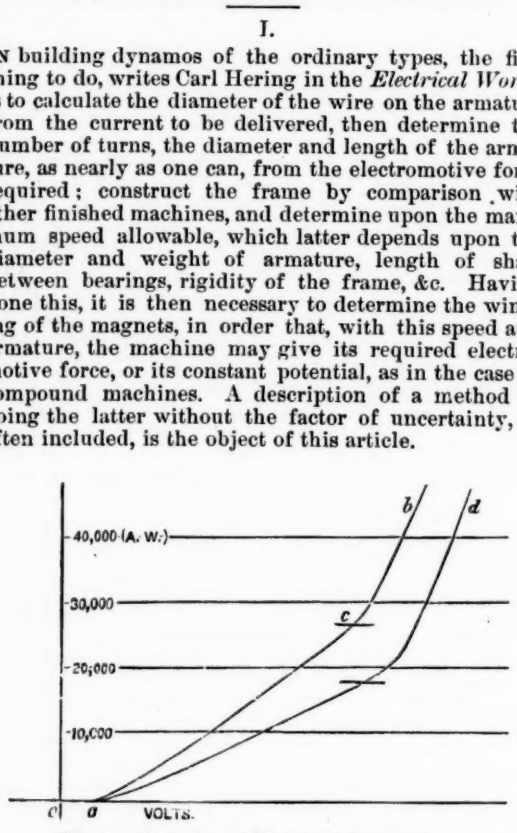


FIG. 1.—DIAGRAM OF MAGNETIC SATURATION.

It is evident that by winding the field-magnets similarly to another machine giving a different current or electromotive force, the former machine will give approximately the required electromotive force or current (depending upon the correctness of the calculation), and that the speed may then be varied until it gives the exact electromotive force. But it is a very uncertain method, for it is very difficult, in most cases, to make the proper change in the winding to correspond with the required change in the electromotive force, and, therefore, the chances are that the necessary speed obtained by experiment will either be too high to make the machine safe and durable, or that it will be too low to give it the required efficiency for the size and cost of the machine.

There is a sure and tolerably exact method, used by the writer, for determining the winding in order that the speed may not be too high or too low; that the brushes may be placed in the proper non-sparking position; that the magnet coils may have the proper resistance, so that they absorb the proper percentage of energy allotted to them, and in order that the cost of the wire on the magnets may not be too great; or that the total energy delivered by the machine may not be too small for its size and cost. By means of this method, the factor of uncertainty, or good (or bad) guessing, is entirely eliminated.

It is well known that the current of a machine depends on the size of the wire on the armature, so that if the armature is determined, that limits the current, at least within certain bounds. The only thing left to do, therefore, after the armature and frame are determined upon, is to make the machine give the proper electromotive force with this armature, while it is delivering the proper current, at the given speed.

As the electromotive force depends upon the speed, the number of windings on the armature, the size of the armature and the magnetism of the field-magnets, it is evident that if the armature and frame are completed and the speed decided upon, the only thing left to vary, in order to make it give the electromotive force, is the magnetism of the field-magnets.

In order to determine this, erect the machine with its proper armature, run it at its proper speed and wind some temporary coils to fit the magnets, being careful to note the exact number of turns of wire on these coils. Now run the machine at its proper speed, discharging the current from the armature directly into a large rheostat, lamps, a tub of acidulated water, or the like, and excite the field-magnets with the current from another machine or secondary battery. It is then only necessary to increase or diminish this exciting current, and to regulate the rheostat in which the current is absorbed until the current delivered by the armature is the proper amount and has the required potential, when the brushes are set to the proper non-sparking position. It is evident that this will enable one to properly adjust all the parts and conditions, and will allow of any slight changes of speed, or the like, which the running of the machine may show to be necessary. When it is running properly and has been "warmed up" sufficiently, measure the exciting current.

The intensity of a field is proportional to the ampère windings or ampère turns on the several magnets, that is, to the number of ampères flowing through the wire multiplied by the sum of the number of turns on all the magnets. It is immaterial whether the current be large and the number of turns small, as in a series machine, or *vice versâ*, as in the shunt machine, or whether it be a combination of both, as in a compound machine, if only the product of the current into the number of turns be the same.

The measurement made as above described will therefore, if the ampères of current be multiplied by the number of windings in the coils, give us the proper ampère windings required to make the machine give its required electromotive force when delivering the proper current. It remains only to calculate the proper size of the wire and the number of turns from this given quantity of ampère windings in order that the finished machine may have the required intensity of magnetic-field or the same ampère windings. This size of wire will, of course, depend on whether it is a shunt, series or compound machine, also on the allowable current or fall of potential in the magnet coils, on the cost of the wire, &c.

Before giving the formulæ in the three special cases, it may be well to call attention to some points which apply to them all.

The temporary coils may be wound on a shell of common tinned iron or the like, to fit the magnet cores. They must all have the same number of windings, and had better be connected in series, for if they are in parallel arc you are never sure, unless the resistances are exactly equal, that they all have the same current, and it is difficult to get both the resistance and number of turns exactly the same in all. They should be made about the same thickness as the finished magnets will probably be, in order to eliminate any difference in the mean distance from the wire to the iron. The size of the wire depends upon the machine or battery at the disposal of the constructor for

the exciting current. If this gives a small current of high potential, use tolerably fine wire; if it gives low potential and large currents, use thick wire. In all cases it is best to make a rough preliminary calculation, so that one is not baffled by the incapacity of the exciting machine.

In the absence of an exciting machine, the coils may be supplied from the machine which is being tested, either by running a shunt current from it into the coils, in which case an adjustable resistance is placed in circuit with the magnet coils to regulate the shunt current; or they may be run in series with the external circuit, in which case an adjustable resistance must be placed as a shunt to the magnet coils, in order to regulate the current in them. In the first case, the armature must be credited with the current shunted off into the temporary coils, and in the second case the electromotive force of the machine must be measured at the poles of the armature and not at the poles of the machine, as there is a loss of potential in the magnets.

There is, naturally, a practical limit to the magnetisation which can be generated in the given cores and pole pieces, owing to the fact that the iron becomes saturated. This limit ought, in practice, not to be exceeded, for if it is, the magnetism becomes expensive as regards the energy consumed. There are some practical values given by different authorities regarding this limit. One of them is to take 110 ampère windings per square centimetre cross section of core, which is equal to 710 ampère windings per square inch. This is probably for round wrought iron cores. The writer found for a certain machine with cast iron oval magnets, 37 ampère windings per square centimetre, or 240 per square inch, to be about the safe and economical maximum. Of course, more than this could be taken, but it is not to be advised, for the magnetism then no longer increases in proportion to the ampère windings. On the other hand, to use much less than this, makes the machine uselessly heavy and large.

As the magnetisation varies less with a varying magnetising current after the point of saturation is reached, some makers prefer to use their machines over saturated, because then the current delivered by them is more constant for slight variations in the magnetising current. In other words, the machine is less apt to change its electromotive force for slight changes in the external resistance. When this is done it is at the expense of the energy consumed by the magnets, and the point of saturation should therefore not be exceeded any more than is necessary to obtain this steadiness.

The size of the core being given, the limit of the ampère windings can easily be determined from the above constant, and it should not be exceeded, at least not much, unless the iron is particularly good. As the economic density of the magnetism, or the saturation limit, depends so much on the iron used, it is better, in all cases where the constructor has the opportunity, to find the proper limit himself by the following method:—

With the machine just as it is for the foregoing test, run it at a very low speed, for instance, belting from the shaft directly; run it on open circuit with a fixed position of the brushes at about the theoretical neutral line. Connect the brushes with a voltmeter, and excite the magnets as before with the current from another machine, beginning with a small current and increasing as high as the wire will stand, measuring in each case the exciting current and the electromotive force at the poles.

The electromotive force on open circuit is a direct representative of the magnetisation of the field, that is, the useful magnetism. The ampère windings, that is, the exciting current multiplied by the number of windings in the coil, represent the cost of the energy to produce this magnetism. By plotting these values a curve is obtained which represents the relation between them, and which will show up to what degree the one rises proportionally to the other. In the accompanying diagram (fig. 1) such a curve has been plotted, the values being taken from an actual case.

The ordinates represent the ampère windings, and the abscissæ the potential. We see from the curve, *a*, *b*, that the useful magnetism, or its representative, the potential, rises proportionally with the ampère windings up to about 27,000 ampère windings, at the point, *c*, where it takes a decidedly different direction. This point is the limit at which the useful magnetism is economically obtained, and is, therefore, the limit to which the machine should be magnetised. It is the point at which the magnets are saturated. Dividing this quantity of magnetism, or this number of ampère turns, by the area of cross section of all the magnet cores, gives the constant above referred to, that is, the maximum allowable density of the magnetism just before saturation. In this special case there were four magnets, each with a cross section of 181 square centimetres, giving, therefore, 37 ampère windings per square centimetre, or 240 per square inch.

The distance, *o*, *a*, shows the remnant magnetism, while that part of the curve, *c*, *b*, shows the increase of magnetism due to the coil itself, after the iron is saturated.

This diagram also shows a very important point to be noticed in building compound machines, to be referred to later.

The speed at which the machine must be run for this test depends, of course, on the range of the voltmeter at our disposal. It should be so chosen that the values for the potential are inside of the range of the instrument, which can be determined by trial. Shunting the instrument with a high resistance, or putting a resistance in series with it, are devices which may be used to reduce the values to the range of the instrument; provided there is no appreciable current allowed to flow, as that would, by shifting the diameter of commutation, change the results.

THE ELECTRIC ILLUMINATION OF LIGHTHOUSES.

LIEUT. JOHN MILLIS, U.S.A., in the report of the Lighthouse Board for 1885, has given a report on observations on the subject of coast lighting by electricity.

The Lieutenant's report commences with a description of the plant at Hell Gate and review of the work done up to date. He says:—"Nine Brush lamps are placed at the top of the tower, and access to them is obtained by means of a counterpoise elevator. The maximum candle-power of each of these lamps by actual measurement is 3,114 standard candles. Two dynamo-electric machines of the Brush pattern form the means of generating the current used, giving about 343 volts at the terminals and 33 ampères. The light has been several times extinguished owing to the inexperience of the keepers, and several such accidents as are to be expected in a new plant, but there have been no interruptions since March 24th, and Lieutenant Millis states that with the greater experience of the keepers, and the electric apparatus being duplicated, there is now little danger of another extinction except from failure of the engine or further trouble with the ice." On one occasion ice formed on the elevator ropes and prevented access to the lamps.

The arc light possesses the qualifications of intensity to an unsurpassed degree, and while experience has shown that its penetrating power is less proportionally than that of a light in which the longer wave lengths predominate, the electric arc is believed to furnish the means of creating a light which for all states of weather will be visible farther than any that can be otherwise produced. The light-giving surfaces in the electric arc are extremely small compared with the intensity, but as the quality of fixedness is to a great extent wanting, the smallness of the luminous surfaces becomes a serious defect rather than an advantage. Much larger optical apparatus is required than would be necessary were the light fixed in position, in order to

diminish the effect of small movements which constantly occur, and frequent adjustment of the light is required. With regard to the light, a notable difference exists between that class of arc lamps operated by continuous current and that requiring an alternating current.

The Lieutenant states that, in lamps of the former class, the most advantageous position is with the carbons vertical, but even in this position the direction of the maximum illumination is 45° from the horizontal. For this reason, and on account of the greater difficulty of keeping the light adjusted to the focus of the lens, continuous current arc lamps in any of the forms heretofore devised are not suited for lighthouse purposes, and their use may be said to be practically abandoned. The De Meritens alternating current lamp, with a lens specially adapted to it, and the De Meritens alternating current magneto-electric machine constitute what may be called the most practicable, and, in fact, the only arc electric lighting apparatus at present in use for lighthouses.

As certain qualities possessed by the incandescent electric lamp promised to render it of use as a lighthouse illuminant, considerable experimental work in this direction has been done.

Incandescent lamps of much higher candle-power have been made, and a lamp for use in a first order lens has been completed, the preliminary tests showing that it can be operated continuously and with safety at about 450 candle-power. Experiments have shown that the readiness with which this form of lamp can be extinguished and relighted promises to render it applicable for intermittent lights with the great advantage of simplifying the optical apparatus and doing away with the revolving machinery. It is a matter of regret, the Lieutenant continues, that it has not been practicable to thoroughly study the relative penetrating power of lights of different qualities by actual observation from a distance, since this constitutes one of the most important features of the whole subject. Such observations as it has been practicable to make indicate, however, that the incandescent light is not inferior in penetrating power to flames, and is without doubt relatively superior to the electric arc, and is, therefore, better adapted than the arc lamps for red lights since the proposition of light of short wave lengths is not so great. The simplicity of the lamp and fixtures required, the ease with which it can be accurately adjusted in position and kept so, the fact that the lamp itself requires no attention while in operation, and the readiness with which it can be applied to any first order lens now in use, with no disturbance of the present illuminating apparatus except the temporary removal of the burner, are some of the further advantages possessed by this lamp which seem to warrant continued and more thorough investigation. The electric lamp curve shows that a large percentage of the light falls upon the refracting drum of the lens which is by far its most efficient part. The amount of radiation that takes place at a greater angle than 45° from the focal plane is so small, that beyond these limits the catadioptric rings of the lens might be omitted entirely. The electric lamp is greatly superior to the oil flame in another respect. The greater size of the flame produces more useless divergence of the light after it leaves the lens, and the form of the flame is variable. Its height is considerably affected by the state of the weather, and unfortunately the lamp always burns poorest in thick weather, when most needed. Besides the diminished luminous intensity which results, the brightest part of the flame is lowered, and if the burner be so placed as to give the best effect when the lamp burns properly during bad weather, the light is not only less bright, but is thrown too high above the horizon. Of electric generators there are now obtainable many varieties, which are well constructed, easy to operate, efficient, and suited to any condition which may occur in practice. Steam motors especially designed for this work have also been carried to a high state of perfection, and the only unsolved part of the problem of the electric illumination of lighthouses, or more properly the part less perfectly solved than any other is that which relates to the lamp itself, and it is, therefore, to this that experiments and study have been principally directed.

DYNAMO TESTING.

THE accompanying illustration represents the two Edison-Hopkinson machines recently tested at the works of Messrs. Mather & Platt by a new method introduced by Dr. John Hopkinson, F.R.S., and which was described in our last issue.

The system is applicable only in special cases which are not likely to arise in practice. The machines were electrically connected as shown in the diagram, where G is the armature of the generator, M that of the motor, F the field magnets of the generator, and F_1 those of the motor, both fields being supplied with current from the brushes of the generator.

It will be seen that if the exciting current were alike in both cases, the counter electromotive force created in M would be equal to the electromotive force created in G, and no current would pass from one armature to the other. To allow a current to flow it is necessary to slightly lower the counter electromotive force of M, and this is done by reducing the exciting current in F_1. In order to regulate the exciting power of the motor field magnets, a rheostat, *r*, is inserted into the circuit. The main current is measured by observing, on a potentiometer, P, placed in a distant room, the difference of potential existing between the terminals of a platinoid resistance, R. This resistance is so low—·0058 ohms—that the strongest current which is used during the range of experiments does not sensibly heat it.

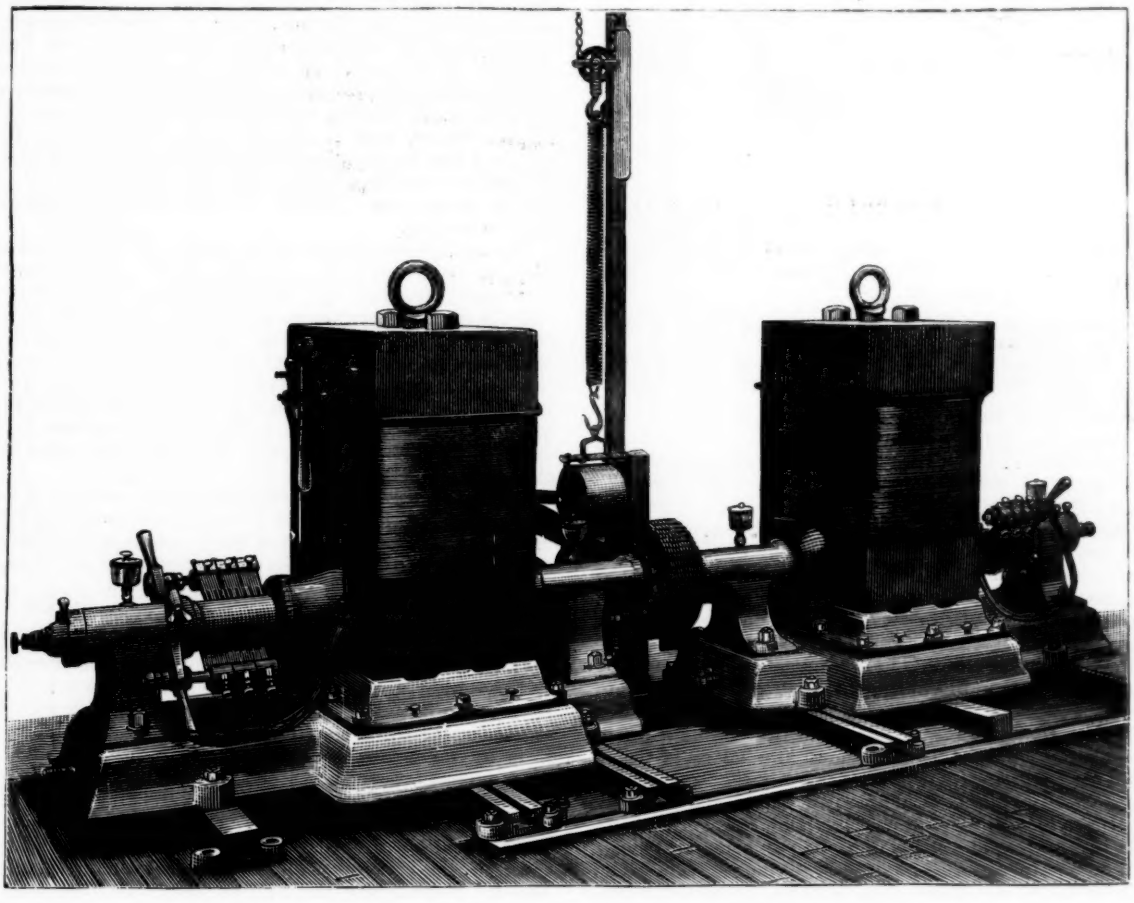
Mr. Gisbert Kapp, the well-known electrical engineer, who was amongst those assembled to witness the experiments made in Manchester, had afterwards an opportunity of repeating the tests, and he gives the results of his experience to the *Engineer* in the following words :—

The experiments were carried out thus :—The two dynamos were first run with the brushes off, neither of the two fields being excited. This gave the power necessary to overcome the friction in the bearings, the resistance of air and that used up in the dynamometer itself. The next experiment was to excite the two fields separately, and run the dynamos still with the brushes off. This gave the power required to overcome the resistances just specified, plus the energy absorbed by revolving the two armatures in magnetic fields, or, as it might be termed, the power absorbed by magnetic friction. Roughly speaking, the magnetic friction was found to increase the power required for running empty by 50 per cent. The field coils were then coupled up as shown in the diagram, and the proper power tests were made. In the following table are given some of the results obtained :—

Dynamometric Experiments on two similar Edison-Hopkinson Dynamos.

Scale divisions on spring balance...	21·6	30	60	48·5	44
Revolutions per minute	808	802	764	808	808
Electromotive force at brushes of generator	—	—	110·12	118·87	124·41
Electromotive force at brushes of motor	—	—	107·34	116·86	122·97
Electromotive force in armature of generator	—	—	113·79	121·56	126·40
Counter electromotive force in armature of motor	—	—	103·78	114·29	121·12
Main current in ampères	—	—	358	258	186
Shunt current in field of generator	—	6·9	6·72	7·21	7·57
Shunt current in field of motor ...	—	6·7	5·23	5·92	6·53
Current in armature of generator...	—	—	370	271	200
Current in armature of motor ...	—	—	358	258	186
Horse-power registered on dynamometer	5·18	7·17	13·66	11·70	10·60
Horse-power converted in armature of generator	—	—	56·20	44·00	34·00
Horse-power converted in armature of motor	—	—	49·80	39·60	30·20

The horse-power converted in the armature of the generator is that actually appearing in the form of internal electrical energy. The power which has to be supplied to the spindle is somewhat greater than the horse-power converted, and the problem is to find how much greater; in other words, we want to find the efficiency of conversion. Similarly the horse-power converted in the armature of the motor is the electrical energy disappearing in the process of conversion into mechanical energy, which flows through the coupling back into the spindle of the generator. This power is somewhat smaller than that given in the table, because a certain loss occurs during conversion, and we want to find how great this loss is. Since the two machines are similar in size, we shall not commit any great error if we assume that the unknown loss in conversion is the same in both armatures. Let x represent the horse-power thus lost. Then we have the following relation



in reference to the experiment given in the third column :—

Power supplied from the external source ...	13·66
Power supplied by the motor	49·80 − x

The sum of these two must be equal to 56·20 + x, which represents the power actually supplied to the spindle of the generator. We have therefore the equation—

$$13{\cdot}66 + 49{\cdot}80 - x = 56{\cdot}20 + x,$$

whence

$$2x = 13{\cdot}66 + 49{\cdot}80 - 56{\cdot}20$$

$$x = 3{\cdot}63$$

It should here be remarked that in taking 13·66 as the power actually supplied to the whole combination we have made no allowance for the loss occurring in the dynamometer itself. Now from the first column it appears that 5·18 horse-power are required to overcome the purely mechanical resistance of the dynamometer, the friction of armature spindles in their bearings and the air resistance of the armatures. The latter two must properly be charged to the dynamos when determining their commercial efficiency, whereas the former should be deducted. It is extremely difficult to separate these losses, and we shall have either to neglect the loss in the dynamometer altogether, which would make the dynamos appear less efficient than they really are, or we must deduct the losses due to the dynamometer and the mechanical friction of the armatures together, which would make the dynamos appear more efficient than they really are. In the latter case the power applied externally would be $13{\cdot}66 - 5{\cdot}18\,\frac{764}{808} = 8{\cdot}76$, and the unknown quantity $x = 1{\cdot}18$.

This value agrees fairly well with the tests in the first and second column where the increase of power due to the magnetisation of the iron core of the armature had been directly ascertained. But there is one point which has not been taken into account, and which would slightly modify the efficiency when either of the dynamos were used in actual practical work. This is the increase of mechanical friction in the bearings due to the strain of the belt. It is a very different thing to transmit 10 horse-power through a belt embracing three-fourths of the pulley, and to transmit 60 horse-power through a belt embracing, say, only four-tenths of the pulley. The strain in the driving end of the belt will, in the latter case, be probably ten times greater, and therefore the pressure of the spindle against its bearing, and the power absorbed by friction, will also be considerably increased. In order to make an allowance on this head, probably the fairest thing to do is to take the mean between the two values for x, and in this case we have :—

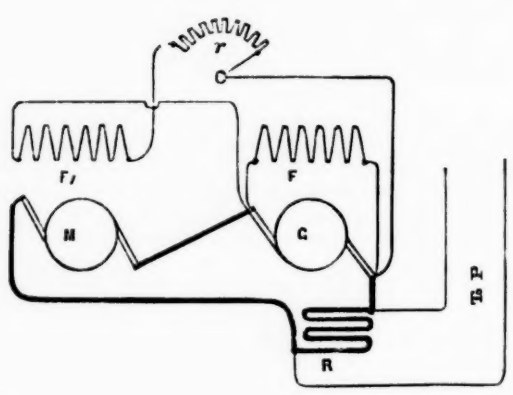
Horse-power in the belt driving the dynamo ...	58·60
Horse-power delivered electrically at the terminals	53·60

Commercial efficiency, 91·5 per cent.

Similarly we have for the motor :—

Horse-power delivered electrically to the terminals	53·60
Horse-power obtainable at the belt	47·40
Commercial efficiency, 88·5 per cent.	

In this case the commercial efficiency is somewhat lower for the motor, which is probably due to the fact that the field-magnets were not fully excited.



In the same manner we find the average value of x for the figures in the fourth column to be 2·36, and that for the figures in the last column to be 2·10. This gives for the dynamo :—

Horse-power in belt driving the dynamo	46·36 and 36·10
Horse-power delivered electrically at the terminals	42·00 „ 30·40
Commercial efficiency	90·6% „ 84%

And for the motor :—

Horse-power delivered electrically to the terminals	42·00 and 30·40
Horse-power obtainable at the belt ...	37·24 „ 28·10
Commercial efficiency	88·7% „ 92%

The method here adopted by the writer in analysing the experimental results is somewhat different from that adopted by Messrs. Mather and Platt, but the results arrived at by either method agree fairly well. The commercial efficiency, determined according to the makers' way of reckoning, is 93·23 per cent. for the tests recorded in the third column, and the discrepancy of 1·7 per cent. is due to the fact that in the calculation which gives the higher efficiency, no allowance was made for the increase of friction in the bearings due to the greater pull of the belt where the latter is transmitting the full power, instead of only that portion of the power which is wanted. These results are very instructive. In the first place, they prove that an actual commercial efficiency of 90 per cent. and more can be obtained with a high-class dynamo. They also show that the dynamo, when designed on sound scientific principles, is equally efficient, whether used as generator or motor, a point which has been much discussed of late in the columns of the scientific press. A very important result of the experiments is also that it has been proved to be possible to electrically transmit energy over short distances with a total loss not exceed-20 per cent.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

XII.

GENERALLY speaking, the storage capacity of a secondary battery depends upon the weight of its active material, provided that this material is distributed in a rational manner, and that the electrolyte is of a volume and strength most suitable for the free decomposition of water and the economical distribution of the gases. Thin plates of large superficial area facilitate rapid action, that is to say, they permit of a higher *rate* of charge or discharge than thick plates of equal weight or volume. The plates of the tramcar cell which we have investigated are, on an average, $\frac{1}{8}$ of an inch in thickness, and they offer a total surface of about 11·5 square feet to the liquid. Under ordinary circumstances these cells are charged at the rate of 30 ampères, and discharged at the rate of about 45 ampères; but frequently they are required for short periods to yield a current rate of 100 and even 150 ampères.

The usual way to test the capacity of a secondary battery is to charge the same at as uniform a rate as possible, taking readings on the ammeter and the voltmeter, say, every half-hour, or even every quarter of an hour, then multiply the ampères by the hours; afterwards discharge the battery through a constant resistance, and note the current and E.M.F. at frequent and equal intervals of time. The *maximum* capacity can be found by overcharging the cells at first and discharging them until the current drops to, say 10 per cent. below the initial current rate; if, for instance, a well "formed" battery received a charge of, say, 200 ampère hours, and it returns only 140, it may be assumed that its capacity is 140 ampère hours, but if the same is recharged with only 140 ampère hours it will be found that a return of only 130 ampère hours may be got out.

The author has found, after numerous tests, that a 23-plate tramcar cell, of the E.P.S. type, when thoroughly formed, will return 140 ampère hours for 153 put in, the charging being done at the rate of 29 to 30 ampères, and discharging with 46 ampères at the commencement and allowing it to drop to 41 ampères, showing an efficiency of over 91 per cent. in ampère hours. This, however, does not represent the commercial efficiency of the accumulator, because this depends upon the total energy, in watts, expended in charging the cells.

The average E.M.F. necessary to send a current of 29 ampères through a cell is 2·4 volts, and the average pressure that can be obtained when discharging at, say, 46 ampères, is only 1·9 volts; therefore, the efficiency of a tramcar cell cannot exceed $\frac{140 \times 1{\cdot}9}{153 \times 2{\cdot}4} = {\cdot}724$ or 72·4 per cent.

If we discharge the battery at a lower rate of current, or if we interrupt the discharge so as to allow it to rest for a few minutes between each reading, then a higher efficiency than that stated above can be obtained, and it is by no means difficult to obtain, at reasonable current rates, a return of 80 per cent of the energy expended in charging a secondary battery.

The annexed table is an average one out of a number obtained with a set of tramcar cells. The variations in the charging currents are due to the irregular dynamo speed. Discharging through an iron wire resistance, the current at first dropped very rapidly as the wire became hot, but afterwards the current rate dropped very slowly.

CHARGE.		DISCHARGE.	
Time.	Amperes.	Time.	Amperes.
6.30	29·96	9.15	55·64
7.0	29·96	9.30	47·08
7.30	29·96	9.45	46·65
8.0	29·96	10.0	46·65
8.30	29·96	10.15	45·0
9.0	29·96	10.30	45·0
9.30	29·96	10.45	45·0
10.0	28·89	11.0	45·0
10.30	29·96	11.15	45·0
11.0	27·82	11.30	44·37
11.30	27·82	11.45	43·87
12.0	27·82	12.0	43·44
		12.15	41·9

With 140 amp. hours' useful capacity, and 114 volts, out of 60 cells in series, we obtain thus 15,900 watt hours, or 21·6 H.P. hours, which at the rate of 46 ampères, including the energy wasted through frequent stopping and starting the car, will give sufficient power to propel the vehicle for over three hours on the line which served as a basis for all our calculations. From the efficiencies obtained with the battery and allowing a loss of 20 per cent. between the engine and the dynamo which charges the accumulator, we find that a steam engine of 120 H.P. will be necessary for the maintenance of the traffic of twelve tramcars. We assume here that no artificial resistances are employed in starting the vehicles or regulating their speeds and powers: for, supposing that there are two motors, giving 1·9 ohms' resistance when joined in series at starting, then the maximum current under these circumstances will only be $\frac{114}{1{\cdot}9} = 60$ ampères; whereas the current on the level road will be 32 ampères. On the other hand, there will be a great strain upon the accumulators when the car is running up inclines, and the motors are (in order to exert their maximum power) joined in parallel; then the current to be supplied by the cells may be 90 or 100 ampères, and the E.M.F. of the same will drop considerably below 1·9 volts per cell, thereby impairing the efficiency of the whole system for the time. Therefore we must provide for these abnormal conditions and raise the H.P. of our charging machinery by at least 22 per cent., bringing it up to 146 H.P.

THE WEST COAST OF AFRICA SUBMARINE CABLE.

THE adjourned debate on the Post Office Submarine Telegraph Contract (St. Vincent to the West Coast of Africa) was resumed on Friday, the 5th inst.

On the question being put "That the contract dated the 19th day of January, 1886, for the construction of a submarine telegraph line from the Island of St. Vincent to the West Coast of Africa be approved,"

Mr. HENNIKER HEATON said he rose to oppose the motion and to move as an amendment "that the whole question be referred to a Select Committee of the House." The cable which under this contract the Government agreed to subsidise for the purpose of its construction was already constructed when the contract was entered into on the 18th of January, 1886. The cable was constructed by the India Rubber and Gutta Percha Company, and it seemed to him that the Treasury minute on this subject was entirely misleading. The person at the bottom of this matter was a gentleman who was greatly mistrusted by those who had any knowledge of these matters—he meant Mr. John Pender, a gentleman who was always looked upon with suspicion; and in asking for a Select Committee to examine into all matters connected with this contract he thought he was making a very reasonable request of the Government. The contract which the House was now asked to sanction bound the British Government to pay £380,000 to John Pender and Company for the construction of a telegraph cable from St. Vincent to the West Coast of Africa. John Pender and Company had already a line of cable on the East Coast of Africa, for which the Government paid a subsidy of £25,000 a year. By now obtaining the contract for the West Coast of Africa, John Pender and Company would obtain a practical monopoly, and he was sure that the House would not submit to a contract of this nature being entered into without the most searching inquiry. He believed that the time had come for the Government of this country to own these cables that connected England with our great colonies, and the effect of this contract was to throw the monopoly of the cable to Australia into the hands of John Pender and Company. While these large subsidies were being paid to one company there was no hope of inducing the Government to construct cables themselves. He had already given notice of motion to the effect that the Government should construct an alternative line of cable round the West Coast of Africa to the Cape of Good Hope, but if this contract were approved his proposal could not be adopted. As announced in the *Times* of the 13th of October, the Gutta Percha Company agreed to construct the cable from St. Vincent to the West Coast of Africa and thence to the coast of Australia without subsidy. Without warning John Pender and Company came in, and, after the cable had been laid down, purchased the rights of the company, and now endeavoured to obtain a large sum of money from the Government as a subsidy for the construction of the cable, although, as a matter of fact, it was already laid down and almost in operation. He could prove that the Treasury minute on this matter was erroneous, and he had other information in his possession which was more suitable for a Select Committee. He was desirous of avoiding saying anything offensive, and he should not state the source of his information except to the Select Committee, but he could readily prove that this contract was of a character which, to use a very mild term, deserved inquiry. If the Government granted an inquiry, as he maintained they were bound to do, they would be enabled to examine various papers, to call witnesses, and obtain other evidence which would enable them to understand the transaction which had taken place, and that evidence would show that the transaction was not an honest one. He did not say one word against the members of the late Government, but this contract was entered into just before they left office, during a time of election excitement, when they were influenced by information put before them of an erroneous character. In consequence of the monopoly granted to John Pender and Company a rival company found that the concession granted to them was of no avail, and that they were entirely in their power. At a time when they were suffering great depression in England he thought that to throw away £19,000 a year, or £380,000, for the construction of a cable on the West Coast of Africa should be condemned. If an inquiry were granted he would pledge himself to produce evidence to show that the contract was not an honest one. He begged to move that the matter be referred to a Select Committee of the House.

Sir H. HOLLAND said that of course he did not know what line the Financial Secretary to the Treasury would take with regard to this subject, but if he might tender his advice it would be not to allow this contract to be referred to a Select Committee. He was somewhat surprised at the insinuations which had been thrown out by the hon. member, who had stated that these transactions, which had been entered into both by the late and present Governments, were not honest. The hon. member further said that the decision of the late Government was arrived at during a period of election excitement. On the contrary, he could tell him that one of the first matters which came before him in July prior to the period of election excitement was the question of this telegraph. It was decided by the late Government that it was absolutely necessary to lay down this telegraph line to the West Coast of Africa. That was an opinion which had been arrived at by the Secretary of State for War, the Admiralty, and the Colonial Office, and he ventured to think that it was hardly possible for the Treasury to refuse to consider the question of this contract. The hon. member had averred that when this question came before them a company had started to lay down a cable. It was true that the India Rubber Company had agreed to lay down a line from St. Vincent, but the line was a quasi-foreign one with which they could make no terms. The hon. member said that the company had now established a monopoly and could charge what rate they pleased, but if he looked at the contract he would see that the rates were laid down and fixed by it. Both the companies tendered, and they both required a subsidy. He denied that they had laid the line in July last. The late Secretary of State for War and the late Colonial Secretary and he himself went again and again over the question of the amount of the tenders and the amount of the subsidy; and the result was that it was reduced to £19,000, which was lower than the subsidy required by the India Rubber Company. The Treasury had no option but to take the best terms they could obtain from the company that would lay down the line to the West Coast of Africa. The Government had to say which company offered the best terms, and after all the attention and examination which had been given to the matter it would be idle to refer it now to a Select Committee. He therefore hoped that the Secretary to the Treasury would adhere to that contract.

Mr. H. FOWLER said that the charge of the hon. member for Canterbury was that they were entering into a contract that was not an honest one. Now, that question had been before three different Governments for a succession of years, and it had been most carefully considered. The matter involved two points—namely, a question of policy and a question of internal administration. On the first question he frankly conceded that the House had both the right and the duty to express its own opinion. That question was whether it was for the political and the commercial interests of this country that a telegraph cable should be laid to the West Coast of Africa. If the House referred to the Treasury minute of February they would find that the Treasury were of opinion that that scheme would be of advantage both to the West African colonies and to this country, commercially and politically. The question was raised in the first instance under the former Administration of the present Prime Minister, and it was considered by the Cabinet of that day that it was for the interests of this country that there should be telegraphic communication with our settlements in West Africa. Anybody who was aware of the grave public inconvenience that had been suffered from the want of that means of communication would be of opinion that that Cabinet decided rightly. That decision was confirmed by the Cabinet of Lord Salisbury, and again by the present Government. Of course the House might, if it chose, overrule the judgment of three successive Governments and of those who, being responsible for the military, naval, colonial, and commercial interests of this country, were all of opinion that it was necessary to have that telegraphic communication. The Treasury, in its permanent officers, possessed a staff of the highest capacity and experience, which was totally incapable of a dishonest transaction. Their fault, if it was a fault, was their desire to safeguard the public interests and to avoid, if they could, all undue expenditure; and it was not likely that the House could enter into a contract on better terms than the permanent officials of the Treasury could

do. The Treasury invited tenders, and they received three, one of £23,000, another of £29,000, and another as high as £102,000. They decided to accept the one for £23,000. There was a difficulty in the way, arising in connection with the Island of St. Vincent not being British territory; but that difficulty having been got over, the company was in a position to complete the contract. Negociations were opened, and he must express his admiration of the manner in which the late Chancellor of the Exchequer was enabled to reduce the subsidy to £19,000, of which the colonies themselves would contribute £5,000. The English Government were only to pay half-rates; they were to have priority for their messages and to have the right to nominate a director to protect their interests; while in time of war they were to take possession of the telegraph. The House was asked to withhold its confidence from the Treasury and to refer the contract to a Select Committee. That was not the mode in which the public business either had been or ought to be conducted. The hon. member for Canterbury, before he concluded, had rather unveiled what was behind. The hon. member said he was very anxious that there should be another cable laid to Australia, and that the Government should own all those submarine cables. They knew what that meant. They knew that the Government paid between £10,000,000 and £11,000,000 sterling for the purchase of the telegraphs, which, he supposed, were not worth above half that sum. And now probably some people would like the Government to buy up the submarine telegraphs also. He, however, hoped that the Government would do nothing of the kind. The policy now being pursued of paying the company for the work they did was the wisest and the best that the Government could adopt. He objected to the appointment of a Select Committee, which, in fact, was a declaration on the part of the House that the Treasury was not competent to do its work. He submitted the whole matter to the house as a question of public policy which had been decided unanimously by three successive Governments without any element of party conflict entering into the consideration of the subject.

Mr. LABOUCHERE congratulated his hon. friend on having adopted the true and proper method pursued by Secretaries to the Treasury in answering inconvenient proposals. No one supposed that the Treasury officials were anything but honourable men, but when a contract was made and submitted to the House surely the House had a right to consider whether it was wise, expedient, or desirable. The Secretary to the Treasury had himself explained how sharply the House ought to look after the Treasury and other Government officials. Reference had been made to the large sum of money which had been paid for taking over the telegraph system of this country. Why was this? Such a large amount of expenditure was due to the fact that the House left this matter to be settled by the Treasury and other officials; and it seemed to him that the hon. gentleman proved that the House could not trust Government officials in matters of this kind, but that they ought to carefully overhaul every contract brought before them. The hon. member who brought this subject forward did not complain that the contract was dishonest on the part of the Treasury, but that the contract was dishonest on the part of those with whom the Treasury dealt. The Secretary to the Treasury said there were two points to look at—one a question of policy, whether it was to the political and commercial interest of this country to have telegraphic communication with our African colonies. He admitted that it was desirable to get this communication as cheaply as possible. What were the allegations made by the hon. member? It was proved that three years ago the Treasury and the postal authorities thought that it was desirable that a cable should be laid between the island of St. Vincent and the West Coast of Africa. Tenders were submitted to the Treasury by various companies. The lowest tender was that of the Eastern Telegraph Company, and the contract was signed on the 19th of January to construct and lay a cable from the island of St. Vincent to the West Coast of Africa for the sum of £19,000 per annum during 20 years. Was this cable then constructed and already laid by another company? The hon. gentleman said no. Would the hon. gentleman accept the news in the columns of the *Times* as a fair statement of the facts? In the *Times* of the 13th of October there was an account of a ship being sent out with a cable by the India Rubber Cable Company to lay this cable. There was a dinner and the usual festivities afterwards. In the *Times* of the 21st of November there was a statement that the cable had been laid. Consequently the allegation was this, and it was a clear one, that the India Rubber Company did lay a cable from the island of St. Vincent to the West Coast of Africa, and the reason was that they were obliged to lay it because they had land lines and small coast lines connecting Bathurst with the Cape of Good Hope. They were really obliged to lay the cable in order to fructify their land lines. When the contract was signed, therefore, with the Eastern Telegraph Company to construct and lay a cable for £19,000 a year, he asserted that, unless those two statements in the *Times* should be contradicted, a cable had been constructed and laid by the India Rubber Company. The India Rubber Company had the exclusive concession of laying cables to the island of St. Vincent. The Eastern Company, when they put in a contract below that of the India Rubber Company, knew very well that they could not carry out the contract; but when the India Rubber Company found that they could not obtain a contract the Eastern Company came and said, "Sell us your cable, then we will get a contract to construct and lay a cable from those two points, and we will obtain £19,000 per annum." The point which he wished to urge on the attention of the House was that a cable had been laid without any contract with the Government and without any subsidy from the Treasury. This statement was in the *Times*, and he could not see the object which the Government had in entering into a contract with the Eastern Company when the work had been done by another company without a contract two months before. The whole system of subsidies was, in his opinion, radically bad. We already paid to the Eastern Company £35,000 for telegraphic communication on the eastern coast of Africa. Now we were called upon to pay another large sum because this company had suddenly bought a cable laid by and belonging to another company. In these circumstances he thought the hon. member was justified in denouncing this contract.

Mr. BADEN-POWELL said the hon. member was quite in error in stating that this contract closely affected Australia.

Mr. LABOUCHERE said this was a link in one of the telegraphic routes with Australia.

Mr. BADEN-POWELL said this cable did not connect Australia with this country, and it was not likely that it ever would.

Mr. HENNIKER-HEATON said it was one of the projected lines.

Mr. BADEN-POWELL thought the contract was one that the House ought to support, as it would be of immense benefit in securing an alternative telegraphic route with our African colonies. He hoped, however, that the Government would take precautions against the evils that might arise in the way of excessive rates if both those routes were in the future to fall into the hands of the same company.

Sir M. HICKS-BEACH said he took immense trouble with this contract, and he believed that in the tender as cut down to £19,000 the country had an exceedingly good bargain. This cable would save many thousands a year by securing telegraphic communication between this country and our colonies in Africa, and thus tending to guard us from native wars. The commercial advantages would also be very great.

Mr. MOLLOY asked whether it was not a fact that the India Rubber Company, a solvent company, were prepared to lay the cable at their own expense, and that some person stepped in, purchased the contract, and then came to the House for a large subsidy. Unless a more satisfactory explanation than had been as yet given was furnished he should oppose the vote.

Mr. MUNDELLA begged to state, by permission of the House, what had been already stated half-a-dozen times, that the India Rubber Company asked for £29,000 a year, that they only laid a small section of the cable, and when they got the contract for the whole distance they handed it over to another company who did it for £19,000.

Mr. ILLINGWORTH complained that the wealthy South African colonies were asked to pay only £5,000. It was the large owners of land in those colonies that were chiefly interested, and it was to make them a great aristocracy that the late wars were waged.

Sir F. STANLEY said that the hon. gentleman was quite mistaken. This contract related not to South Africa, but to the West African settlements. The fervid imagination of the hon. gentleman had run riot with regard to large landholders. He did not know that the proprietors in the West African colonies possessed even "the three acres and a cow." The hon. gentleman thought £5,000 was very little to pay, but the fact was that the matter had been very carefully looked into, and the proportion of £5,000 was allotted on a fair basis. He believed this contract would be the means of securing the prosperity of a large portion of Africa.

In answer to Mr. Brunner,

Mr. H. FOWLER said that the India Rubber Company asked between £20,000 and £30,000. The company proceeded to lay a small portion of the cable—about one-sixth of the whole—and ultimately when they got the complete contract they sold the cable they had laid, with their rights, to a company with whom his right hon. friend opposite arranged better terms.

The House divided, and the numbers were—

For the amendment	34
Against	199
Majority	—165

The motion was then agreed to.

Lighting of the Liverpool Exhibition.—The electric lighting of the Liverpool International Exhibition, which is now approaching completion, has been entrusted to the Liverpool Electric Supply Company, Limited, Messrs. Holmes and Vaudrey being the engineers. More than 300 arc lamps will be distributed through the buildings (which cover eight acres), and several thousand incandescent lamps. The dynamos will be supplied by the Anglo-American Brush Company. The motive power will consist of six semi-fixed compound engines with boilers attached, two pairs of 40 H.P. compound engines, and four separate fixed engines, the latter supplied with steam from three large boilers of the locomotive type. All the engines and boilers will be supplied by Messrs. Marshall, Sons and Co., of Gainsborough. The Liverpool Electric Supply Company will also exhibit, in conjunction with Messrs. Crossley Bros., of Manchester, several sets of electric light plant driven by gas engines.

NOTES.

The Electric Light in the Royal Navy.—Some exhaustive trials of the electric search light have been made on board the sloop *Icarus*, at Devonport, by Commander Crawford J. M. Conybeare, representing the Admiralty, and they were pronounced to be of a highly satisfactory character. The experiments lasted for about three hours. The light was moved round to every point of the compass, and objects were seen at a considerable distance almost as easily as if it had been daylight. The *Icarus* is destined to relieve the *Pelican* on the Pacific station.

Lighting at the Indian and Colonial Exhibition.—The Quadrant dining rooms, refreshment rooms, and some other parts of the Indian and Colonial Exhibition are to be supplied from storage batteries, manufactured by the Electrical Power Storage Company, Limited. The batteries will give current for a total of about 1,000 lamps. As this is the largest public exhibition of storage batteries which has yet been made in London the working of these cells will no doubt be watched with considerable interest.

The National Gallery and Electric Lighting.—In the House of Lords on Tuesday Viscount Hardinge rose to move :—"That an humble address be presented to Her Majesty for copy of a memorandum drawn up and signed by the director and trustees of the National Gallery with reference to the risks and inconvenience attending the proposed opening of the Gallery on week days up to 10 p.m." The noble lord stated that the objections of the trustees to opening after dusk were chiefly these :—The electric light was in its infancy, with no guarantee against occasional extinction. Large crowds assembling at night in the Gallery would stir up an unusual amount of dust. The breath of a large number of persons congregated together generates gases which occasion a hurtful deposit upon the pictures, and it is impossible to cover all pictures with glass. With respect to the advantages which would accrue to the working man it was very doubtful whether, after a hard day's work, working men would leave their homes to visit the Gallery.

Electric Lighting in Leeds Town Hall.—Some time ago the Electric Lighting Committee of the Leeds Corporation resolved to illuminate the Victoria Hall by means of arc lamps, at a cost of about £450, in place of the sunlights which form the latest improvement in gas lighting in the hall. It may be recollected that on the occasion of the last Musical Festival, in October, 1883, the hall was illuminated by means of incandescent lamps by Messrs. Crompton and Co. The "electroliers," which are the property of Messrs. Crompton, have not been removed, and if the Musical Festival Committee should prefer the incandescent lamp to the arc lamp, they will be allowed to remain until after the Musical Festival in October next, when the Electric Lighting Committee will proceed to fix the arc lamps. Two arc lamps have just been suspended in the hall, and the Electric Lighting Committee has had an opportunity of inspecting them. So satisfied were the committee with the lamps that others were ordered to be fixed. The installation in its entirety will consist of eight arc lamps, driven by secondary batteries, sufficient for a 10 hours' run, placed in the Municipal Buildings, and the remaining lamps, with the necessary wires, &c., are in readiness to be put up. The lamps are the Brockie-Pell patent. They are fixed upon pulleys, so that they may be varied in height up to 46 feet, and the cleaning and renewing of carbons can be effected by a person standing in the body of the hall. The secondary batteries are charged by dynamos which the Corporation already have in the basement of the Municipal Buildings. The pair of 12-horse (nominal) power Otto gas engines, by Messrs. Crossley Brothers, which supply the dynamo power for illuminating the Public Free Library, are at present standing idle during the day, and can therefore be utilised for the Victoria Hall. The engines are coupled, so that in the event of one dynamo breaking down, the whole of the power could be run upon the other dynamo. The current is carried from the basement of the Corporate Offices to the Town Hall along a subway in Calverley Street, and thence into the false roof of the Victoria Hall, from which the arc lamps are suspended. The work has been carried out under the superintendence of Mr. Hewson, the borough engineer.

Electric Lighting of Railway Carriages.—The *Times* states that it has been decided to extend the system of electric lighting on the trains of the Brighton line generally, so that before long, all passengers by this line may hope to experience the benefit of being able comfortably to read their newspapers during their railway journeys.

Electric Lighting in Rolling Mills.—At a recent meeting of the South Staffordshire Institute of Iron and Steel Works' Managers, Mr. G. B. Wright, of Wolverhampton, read a paper on "The Electric Light as Applied to Rolling Mills," in the course of which he said : So far as direct glow lamp lighting is concerned, it does not appear likely that any considerable advance can be made, and we have in it, beyond question, a steady, reliable, and economic servant. I am in a position to speak confidently of the cost of maintenance, for, in each example given, I have supplied the apparatus, and maintain it under contract, at a price well below the cost of gas.

Courteous Competition.—A novel means of discrediting a rival electric lighting company has been resorted to by the Edison Company in Louisiana, and a means which is unworthy of a corporation engaged in a genuine business. A notice in the terms following was recently distributed by the representatives of the company :—"Electric Light ! The people of Louisiana should be very careful how they hang their faith on upstart electric companies represented by drummers, whose pay depends merely on sales or 'pull-ins.' There are a few companies that have passed the experimental day and can be relied upon. All others should be shunned until they drop the swaddling clothes of experiments, and the Schuyler Electric Company is one of them. W. J. Dougherty, Representing the Edison Electric Light for Louisiana." The Schuyler Company has done a great deal of good work and has acquired a very favourable reputation in the States ; such an exhibition of trade jealousy is not likely to greatly injure its prospects.

Experiments with the Telephone.—Mr. J. S. Holt, of the United Telephone Company, exhibited a number of interesting and successful experiments last week, at the Lecture Hall, in Peckham Park Road. The object of the lecture and the experiments was to raise funds to assist the Society for the Aid of Ladies in Distress, and the audience were highly gratified to find that Mr. Holt, with the assistance of Mr. Crack and several other members of the company's staff, had made elaborate preparations to enable 40 persons at once to use the instruments connected, for the occasion, with a room up the road on the opposite side. An introductory lecture by Mr. Holt, introduced the subject in its technical aspect. The practical demonstration included the following : Into the phonograph during the afternoon a gentleman had played on the cornet "When other lips and other hearts," and the air was reproduced after the evening lecture by unwinding the tinfoil drum. The sound was not greatly diminished, but several of the notes were flat. This, however, might have been the fault of the musician ; or, shall we say, was due to the hitherto undiscovered transposing powers of the apparatus ? The audience were highly delighted. The spoken lines—"To be or not to be," &c., were also re-delivered almost as spoken. The audience were then treated to some vocal music through the Blake transmitter and chalk receiver. The vocalists

were up the road at the other end of the wire, and the music was transmitted through the "chalk" loud enough for all to hear easily. A vote of thanks to Mr. Holt was carried with loud cheers.

Telephone Extension.—The National Telephone Company is building a telephone line between Glasgow and Kilmarnock.

Telegraphic Addresses.—Writing from the Junior Athenæum Club, W. H. C. says :—"A new word is wanted more suggestive of brevity than the phrase 'Telegraphic address' now being inscribed on our cards and notepaper. How would 'Telenym' do ?"

Telegraphic Revenue.—The receipts on the telegraph service, from April 1st, 1885, to March 6th, 1886, amounted to £1,600,000, against £1,610,000 received from April 1st, 1884, to March 7th, 1885.

The Distribution of Electricity.—Has not our correspondent Mr. Jackson mistaken the kind of machines which are employed in connection with secondary generators or transformers ? This, however, does not affect his main object in writing to us.

Losses in Electro-Motors.—Mr. Mordey will probably feel interested in the comments made upon his recent paper by Capt. E. Dubois. M. Marcel Deprez evidently has not yet learned the best mode of constructing these apparatus.

Secondary Batteries as Regulators.—We shall be pleased to receive communications from our readers on the subject of Mr. Littleton's letter which appeared in our last issue. Sir David Salomons, with his invariable readiness to assist others, comes forward with facts which we hope may enable Mr. Littleton to remedy the defect of which he complains ; others, should such a case have come before their notice, may possibly be willing to give these experiences.

M. Marcel Deprez.—On the first day of the present month M. Marcel Deprez was nominated member of the *Academie des Sciences*. His labours upon the transmission and distribution of electrical energy have been pursued for several years past with a constancy which ought, even if it does not, ensure success. Unfortunately, however, M. Deprez has only succeeded in realising to a very moderate degree in practice that which was already well understood theoretically. Even with the munificent support of M. Alphonse de Rothschild in the Creil-Paris experiments, the results obtained were more discouraging than otherwise. Nevertheless, we congratulate M. Deprez upon the distinction which the *Academie des Sciences* has thought proper to confer upon him, for we believe his talents and energy may yet be turned to better account.

Local Authorities and Overhead Wires.—From our report under the above heading in last week's issue, it will be seen that the Western Counties and South Wales Telephone Company has petitioned to be heard by counsel against the Torquay Harbour and District Bill. The promoters having contested the right of the company on the ground that it has no *locus standi*, this question will be shortly considered by the Court of Referees of the House of Commons, who will decide whether the company can be heard against the Bill on its merits.

Overhead Wires.—Mr. M'Iver asked the President of the Local Government Board, on Thursday last week, whether it was proposed, in dealing with overhead telegraph and telephone wires, to give corporations and urban authorities power to make by-laws or regulations with respect to such wires for the protection of life and property. Mr. J. Collings replied that the Board had no doubt that if a measure were brought in dealing with overhead wires, powers would be conferred on urban sanitary authorities to make by-laws or regulations with respect to such wires.

The New Electric Tramway on Ryde Pier.—A preliminary trial, in connection with the new electric tramway on Ryde Pier, took place on Saturday in the presence of some of the directors and a few gentlemen, who had been invited to be present. The car which was selected for the trial (being the first completed) was in charge of the representative of Messrs. Siemens, under whose superintendence the work of fitting the electric apparatus has been carried out, and its performance was considered to be satisfactory in the highest degree. A light and rather handsome structure has been erected at the south east end of the pier for the accommodation of an Otto gas engine, which indicates 22 horse-power. In the same building is located one of Messrs. Siemens's powerful dynamos, from which the current is conveyed to the west side of the pier, and thence to the train terminus at the pier head, by an iron rod. The return circuit is along the rails, which have been prepared for the purpose. From the side of the car projects a light steel spring, which is brought into contact with the rod, thus immediately completing the circuit and setting in motion the motor. From information supplied to us, and published in our columns on the 5th of February last, the belief might have been established that secondary batteries were to be employed. The above brief description of the actual method of working will, however, disabuse one's mind of any such erroneous impression. It is intended to light each of the cars by means of electricity, which will also be used in the new building. It is believed that the system which is just being inaugurated will prove in the end far more economical, and, at the same time, more efficient than the method of traction which it has superseded. Ryde being situate in one of the most pleasant parts of the Isle of Wight, and being within easy reach of Portsmouth, is visited during the summer by large numbers of excursionists, and no doubt the novelty of a tramway propelled by means of electricity will be an attraction to many persons to ride who might otherwise walk.

A Literary Majority.—Last week the *English Mechanic* entered upon the twenty-second year of its exceedingly useful life, and prominent amongst the contents of the issue is the first of a series of papers by "Xero," on "Practical dynamo building for amateurs."

Society of Arts Meetings.—On Wednesday evening last a paper on "The Experiments with Lighthouse Illuminants at the South Foreland," was read by E. Price Edwards.

Magnetic Screens.—Prof. Anthony, of Cornell University, has published in one of our New York exchanges a short article on "Magnetic screens." This we hope to reproduce in an early issue.

Central Stations for Electric Lighting.—The Edison Central Station in Boston, U.S.A., is being rapidly pushed forward. It is intended to start with 2,000 lights, to be increased eventually to 6,000. These will be used by the theatres, stores, and hotels in the vicinity, and the wire will be run underground.

The Electrical Transmission of Power.—The papers read at the Baltimore Convention, several of which were reproduced in our issue of last week, brought out with great force, says the *Electrical World*, the probable future of electric light stations. In the near future, every dynamo plant will be a lighting station at night and a power station during the day.

The Edinburgh International Exhibition.—It was reported at the last meeting of the committee of the International Exhibition that Messrs. Arrol & Co., Glasgow, have generously offered to erect an iron bridge to cross over the court for the machinery in motion, extending to 400 feet eastward by 150 feet. The electric lighting of the main avenue, which requires 1,444 incandescent lamps to light it up was stated to be in a forward condition.

A New Turbine.—A new turbine of American design is illustrated in the *Electrical World* for February 27th. The wheel is made in one casting, without bolt or rivet, possessing, therefore, great strength. It is also formed so as not to be liable to clogging, and is designed to give maximum efficiency with every position of the gate.

Dynamo Testing.—We would call attention to the contribution to our "Correspondence" columns from the pen of Captain P. Cardew, R.E., on the subject of testing dynamo-electric machines, and we should still be pleased to receive any criticisms on the method introduced by Dr. Hopkinson for testing the Edison-Hopkinson dynamos.

The suggestion made by Lord Rayleigh and the practice of Captain Cardew will doubtless commend themselves to Dr. Hopkinson, and may we not in further experiments look for still higher efficiencies? We would, however, remind our readers when comparing data obtained with different machines, that small motors of from ½ to 4 or 5 horse-power, and with considerable internal resistance, must not be placed in the same category with a 50 H.P. Edison-Hopkinson dynamo.

Obituary—Auguste Guerout. — We regret to announce the death of M. Auguste Guerout, for the past five years editor of *La Lumière Electrique*. After finishing his university life in France, he studied first at Goetingue under Prof. Woehler, then at Manchester in the large chemical works of Mr. Grace Calvert, where, in addition to completing his technical education, he acquired a knowledge of the English and German languages. On returning to Paris he entered the laboratory of Antoine Cæsar Becquerel, and afterwards accepted an appointment in the firm of Ruhmkorff. At this time he contributed articles to *La Lumière Electrique*, the editorship of which was offered to him towards the close af the year 1880. He died at the village of Sainte-Croix-Montvilliers (Seine Inférieure), on the 28th day of February, after a long illness.

Torpedoes Electrically Steered.—The Edison Machine Works of New York are, it is said, building for the U.S. Government a number of electrical torpedoes. These are propelled, steered and exploded from the shore by electricity. For the purpose of steering two powerful electromagnets are placed in the after part. When the torpedo is going straight ahead the rudder is held in the centre, but by the operator moving a small lever on shore the current passes from one electromagnet to the other, and the rudder is put over in the required direction. A speed at the rate of over 11 miles an hour has been reached on government tests, but it is expected that this will be exceeded. The charge consists of 400 pounds of dynamite. These torpedoes have been tested by being anchored in front of a fort and kept under a concentrated fire for hours, until the float has been completely riddled, and they have yet been ready for active service.

Marriage of Mr. Edison.—Mr. Thos. A. Edison was married to Miss Mina Miller, of Akron, Ohio, on February 24th, Lieut. F. W. Tappan, U.S.N., acting as groomsman. Mr. and Mrs. Edison will spend the winter months at the groom's Florida home.

Arago.—The celebration of the centenary of Arago which has lately taken place at Perpignan under the auspices of Mons. Granet, Minister of Posts and Telegraphs, may render a short account of this celebrated scientist of some interest. François Arago was born at Estagel on February 26th, 1786, and was educated at the College of Perpignan. At 17 years of age he was admitted into the Polytechnic School after a most brilliant examination. Notwithstanding his political opposition to Napoleon, the Emperor in 1806 selected him, in conjunction with Biot, to carry out certain meridional measurements upon which the metrical system is based. During these operations Napoleon declared war against Spain, and Arago after having been a prisoner of war, captured by a privateer, confined on a hulk, and passing through numberless adventures, managed to return to France, having saved his instruments and papers. At the age of 23 he was Member of the Academy of Sciences, Professor at the Polytechnic School, and a little later Director of the Observatory. One of his most remarkable attributes was the wonderful simplicity of his language and the ease with which he gave popular explanations of the most difficult problems, the most abstruse theories or experiments. His lectures at the Observatory were followed with the greatest interest by old and young, scientists and ladies of fashion. He took some share in politics, being elected Deputy for the Pyrenées Orientales, in 1830, but did not succeed very well, being probably too plain spoken, for his political opinions, although he belonged to the extreme left, were the real cause of the present Municipal Council of Paris refusing to participate in the celebration. When 44 years old he was elected as Life Secretary to the Academy of Sciences. Although he refused allegiance to the Second Empire, the admiration of his worth and his scientific attainments was so great, that he was allowed to enjoy his various appointments and the honours and dignities showered upon him by nearly the whole of Europe. He died in 1853, at the age of 67.

Comparisons in Electric Lighting.—The recent experiments of the Franklin Institute upon incandescent and arc lights, according to *Science*, give the following averages:—One pound of anthracite burned under a good boiler yields, in the incandescent system of lighting, about 40 candles; the same weight of coal gives from the naked arc light about 158 candles; ordinarily arc lights are shaded so as to lose about one-half their intensity, so that only 80 candles per pound of coal are available; one pound of bituminous coal will yield from five to six cubic feet of illuminating gas; this gas will, in the standard argand burner, yield from 14 to 17 candles. Illuminating gas is burned at once in the simplest manner, and the amount of machinery and care required by electric lighting offsets its greater economy of fuel, light for light. There is little room for improvement in dynamos, but the most important economies will arise from more skilful use and design of the steam engines required to drive the dynamos. The steam engine, although much the senior of the dynamo in the list of inventions, is not nearly so well understood. It is but very recently that the laws of condensation and expansion of steam in the engine actually at work have been grasped, and our limitations so clearly defined as to point out the logical way to greater economies, and prevent us from attempting economy under impossible conditions.

A Prosperous Company.—The Middlesex Electric Light Company, of Lowell, Mass., is said to be one of the most prosperous corporations of the kind in the States. The station of the company is one of the most conspicuous and attractive buildings in Lowell; and the entire equipment of the plant, from its enormous 250 horse-power engine down to the smallest dynamo, is first-class in every respect. The wiring and poles throughout the city indicate the handiwork of skilled linemen. The system in use is the Thomson-Houston, and the 273 arc lights (3,000 candle-power), all of which have been running for several months, have given thorough satisfaction. Orders are in the hands of the company for many more lights, and the manager has been constantly pressed of late to add an incandescent plant to the station—upward of 1,000 lamps being already guaranteed.

The Electric Carbon Storage Company of Scotland, Limited.—It will be in the remembrance of those interested, that two dividends have already been paid in this liquidation matter, amounting together to ten shillings in the pound, and we have pleasure in an-

nouncing that the stumbling block to a possible further payment has now been removed. The mortgagees claimed the whole of the proceeds from the sale of the assets in Scotland, they holding a mortgage on the machinery and fittings for £2,000 from Mr. Hope. The Liquidator proposed to dispute this claim, which would have been a difficult and expensive matter, and involved a conflict between the English and Scotch law relating to the rights of mortgagees. An agreement has now been submitted to, and has been confirmed by, the Court, compromising the claims of the mortgagees for £500. The result of this is that the Liquidator will now be in a position to at once ascertain the costs of the liquidation, and declare a final dividend, which he hopes to make at least five shillings in the pound.

The Electric Light at Lloyd's.—The extensive suite of rooms occupied by Lloyd's in the Royal Exchange has been successfully lighted by electricity by means of storage cells, the installation constituting, according to the *Times*, the most recent example of interior electric lighting and possessing several special features. The machinery and apparatus are placed in two large vaults in the basement of the Exchange, the current being produced by means of two Elwell-Parker four-pole shunt-wound dynamos, each giving 200 ampères and 75 volts. These machines are driven at a speed of about 600 revolutions per minute direct from a Davey-Paxman compound semi-fixed engine of 20 horse-power nominal, but which is sometimes worked up to 45 horse-power. This plant supplies the current to about 400 Edison-Swan glow lamps, each of 10 candle-power and 50 volts. The installation was completed and the lighting began towards the close of last year, and proved most successful in all respects save one. Soon after the start objection was taken by some to the noise and vibration, supposed to have been caused by the engine, which, however, is very quiet and steady in running. Be that as it may, all cause of complaint was removed by the introduction of storage cells, which are charged from the dynamo before and, if necessary, after business hours. The battery room adjoins the dynamo room, and in it are compactly arranged two sets of accumulators, each set being composed of 29 batteries, and each battery consisting of three cells joined in parallel, giving 180 ampères. The 29 sets of threes are joined up in series, giving 58 volts. There is therefore a total of 174 cells. They are all the Electrical Power and Storage Company's cells of the latest type, and the combined accumulators when fully charged are capable of supplying the current to the whole of the lamps for about eight hours. Between the dynamos and the batteries is an Elwell-Parker automatic cut-out by means of which the return of the current to the dynamos is prevented should their rate of working fall below the normal speed. The conductors from the batteries to the lamps are carried in separate troughs, and safety fusible plugs are used throughout. The whole of the current is manipulated from two main distributing switch-boards which were designed by the Electrical Power and Storage Company, and which afford facilities for varying the number of cells, both in the charging and discharging circuits.

Self-Induction in Conductors.—We understand that Prof. Hughes will endeavour to answer all questions relative to his paper, recently read before the Society of Telegraph-Engineers and Electricians, in the *Journal* of that society. It would not be fair to those who took part in the discussion if the Professor answered queries indiscriminately in the various technical journals.

Economy in Electrical Conductors.—We are reluctantly compelled, through pressure on our space, to leave over the papers read last night before the Society of Telegraph Engineers and electricians, which include an important one on "Economy in Electrical Conductors," by Profs. Ayrton and Perry.

The New York Electrical Society.—At the last meeting of this society, Mr. Henry D. Hall, the inventor of an ozone machine, delivered an interesting lecture upon the generation of ozone by statical electricity. The meeting was held in the rooms of the Ozone Machine Company, in the *Post* building, in Broadway, and the modified Holtz machine employed was run by an electro-motor connected to the Edison electric light circuit. Mr. Hall, after describing the principles of his machine, gave a *résumé* of the uses to which ozone can be applied in the arts and in medicine, and demonstrated its utility for numerous purposes.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Standard Electric Light and Power Company, Limited.—The annual return of this company, made up to the 15th April, 1885, was filed on the 8th inst. The nominal capital is £300,000, in £10 shares. 9,707 shares have been taken up, and upon seven of these £1 per share has been called, the remaining shares being considered as fully paid up. The calls paid amount to £6.

Byng Telephone Company, Limited.—The registered office of this company is at St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.

Railway Electric Lighting Company, Limited.—The business, &c., taken over by this company is purchased upon the terms of an agreement with the Railway Electrical Contractors, Limited. The consideration is £30,000, payable £12,000 in cash, 1,200 fully paid shares, and £12,000 by the allotment and issue to the members of the old company of 4,800 shares credited with £2 10s. as paid upon each; and for the purpose of determining the stamp duty payable on the assignments of the English patents, it is agreed that the sum of £1,000 shall be taken as consideration for the assignment of each of such patents.

Davis and Timmins, Limited. — The registered office of this company is now situate at 24, Charles Street, Hatton Garden.

J. E. H. Andrew and Company, Limited (gas and electrical engineers).—An agreement dated 19th ult. and filed on the 3rd inst., regulates the sale to the company of the patents and business of J. E. H. Andrew and Co. for £11,280, of which £6,000 is payable in fully paid shares. Mr. Hugh Williams, C.E., of Lyme Street, Stockport, is appointed consulting engineer to the company.

CITY NOTES, REPORTS, MEETINGS, &c.

The India Rubber, Gutta Percha and Telegraph Works Company, Limited.

AT an extraordinary general meeting of this company, held at the Offices, 106, Cannon Street, E.C., on Tuesday, the following resolutions, which were passed at an extraordinary general meeting held on February 18th, were submitted for confirmation, and were confirmed:—

"1. The board of directors may from time to time appoint one of their number or any other person to be a managing director of the company, and may determine the amount of his remuneration and the terms of his engagement, but no such engagement shall be for a longer period than five years. A managing director shall not retire from office by rotation during the period of his engagement.

"2. The number of directors (including any managing director) shall not exceed seven nor be less than four, and every director shall hold at least 100 shares in his own name as the sole holder thereof. The directors may from time to time appoint any additional directors or director, provided the number of directors shall never exceed seven.

"3. The remuneration of the directors other than a managing director shall be from time to time determined by the members at the ordinary meeting; but any proposal for the alteration of the remuneration of directors shall be deemed special business, requiring seven days' notice to be given thereof.

"4. The directors may from time to time sell, lease, exchange, or otherwise dispose of and deal with all or any parts or part of the property of the company situated in France upon such terms and in such manner as they may think expedient."

Mr. Cater, a shareholder, on the proposition for the confirmation of the third resolution, said he saw by the balance sheet that the minimum remuneration of the four directors was £2,000, and the extra remuneration was £2,695, giving each director £1,173 18s. 10d½d. If the number of directors was to be increased to seven, including the managing director, then the amount would be, at the same rate, £6,874 1s. 7d., and if the managing director was to receive more than the others, the sum would be still larger. He held in his hand the balance-sheet of the Telegraph Construction and Maintenance Company, which transacted a very similar business, and from that he found that the board of that company consisted of six directors and the managing director, and the remuneration they received was £2,000, with £1,991 as extra remuneration, giving £570 2s. 10½d. each. Could any explanation be given on this subject?

The Chairman said the answer was, that the *maximum* remuneration to be paid the directors was £5,000, according to a motion passed some years ago, and which would not now be interfered with, whatever the number of directors might be.

Mr. Cater then desired to know whether the managing director's remuneration was included in that sum, and when informed that it was not, asked what that gentleman would be paid.

The Chairman replied that that question was discussed at the last meeting, and the shareholders decided that it was not desirable that the amount which the managing director would receive should be made public.

The resolutions were all unanimously confirmed, and the meeting separated after a vote of thanks to the chairman.

The National Company for the Distribution of Electricity by Secondary Generators.

THE report of the directors states that the anticipation of a profitable business, which they ventured to express in the report presented to the shareholders at the general meeting held on the 9th of February, 1885, is being realised.

The seven months of 1883, and the whole of 1884, formed a period of preliminary work, undertaken with a view to demonstrate the company's system. The amounts expended on the trial installations on the Metropolitan Railway and at Turin, though large, seem to have been fully justified by results.

The accounts submitted to the meeting show a profit of £4,570 10s. 7d. after deducting all expenses. After writing off from this balance £574 4s. 2d. for depreciation of plant and a proportion of preliminary and other expenses, there is a net balance of £3,996 6s. 5d., out of which the directors propose to pay a dividend on the preferred shares at the rate of 10 per cent. per annum, from the respective dates of allotment to the 31st December, which will absorb £2,207 6s. 4d., leaving to be carried forward £1,789 0s. 1d.

An amount of £1,087 16s., received from the Banque d'Escompte de Paris on the 13th of February in this year, as balance of the guaranteed minimum for the year ending 1st February, 1886, does not enter into the 1885 accounts, although 11-12ths were really earned in 1885.

The installation at the mines and works at Ascherslebeu, in Germany, has been in operation for a considerable period, and is being extended. The installations at Turin and Tivoli, though progressing satisfactorily, are less advanced. The profits of these works will appear principally in the accounts of the current year.

The directors, therefore, have pleasure in pointing to the fact that the profits for the current year have already a considerable basis from matured business, while the prospect of new business is promising from several quarters.

The directors have pleasure in announcing the conclusion of a contract with Mr. George Westinghouse, jun., of Pittsburg, for the working of the company's patents in the United States of America. The character and position of Mr. Westinghouse justify the expectation of important results from this arrangement. As in the case of the Banque d'Escompte, Mr. Westinghouse guarantees a minimum annual return to the company.

The shareholders are probably aware that a gold medal was awarded to the company at the Inventions Exhibition, South Kensington, "for the successful working out of a system of distribution of electricity by induced currents."

The installation at the Grosvenor Gallery, undertaken by Sir Coutts Lindsay and Company, is not yet complete, In regard to this installation, the company has no responsibility beyond the supplying of their apparatus.

The successful opening of the installation at Tours, under the direct supervision of the chief engineer of the company, has produced a marked impression in France, and promises to lead to a large employment of the system there.

In order to enable the payment of the dividend now recommended, without crippling the resources of the company, the directors waive their claim to remuneration up to the end of 1885.

The directors believe the time is not far distant when a dividend on the ordinary shares may be looked for; they base this expectation on the growing appreciation of the system by scientists and the public.

Mr. D'Oyly and Sir J. Mackenzie, the directors who retire by rotation, offer themselves for re-election. In pursuance of Article 70, Mr. Gustav Defresne was elected to fill the vacancy on the board of directors occasioned by the death of Mr. Le Fez; this appointment will be proposed for confirmation. Mr. J. H. Thornton, the retiring auditor, will be proposed for re-election for the current year.

The Liverpool Electric Supply Company, Limited.—The directors, in presenting their annual report, recommend a dividend at the rate of 6 per cent. on the paid-up capital of the company. The dividends for the two previous years, 1883 and 1884, were at the rate of 5 per cent. per annum. The report states that, in addition to the contract for the whole of the electric lighting of the Liverpool International Exhibition, the company has other important orders in hand, and arrangements are in progress for a large extension of electric lighting from the company's central supply stations.

The Western Union Telegraph Company, Limited.—A Reuter's telegram, dated New York, March 10th, states that the Western Union Telegraph Company has declared a quarterly dividend of 1½ per cent., payable in scrip. According to the financial article in the *Post* it appears that the company has not earned the last two dividends, and that the scrip dividend is due to the decrease in revenue and the increase in expenses for taxes and repairs.

Western and Brazilian Telegraph Company, Limited.—The *Times* of Thursday states that on the previous day Western and Brazilian Telegraph shares were largely bought on rumours that the negotiations with the Brazilian Government are making satisfactory progress. The ordinary shares advanced ⅛ to 7 $\frac{9}{16}$, and the deferred $\frac{5}{16}$ to 3¼.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 5th were £2,724, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for February, 1886, were £18,800; from January 1st to February 28th, 1886, £38,680; in corresponding month of 1885, £41,200; and of 1884, £38,680.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending February 28th were £3,300.

The Brazilian Submarine Telegraph Company, Limited. The receipts of last week amounted to £3,737.

NEW PATENTS—1886.

3053. "Electric arc lamps." W. L. WISE. (Communicated by G. Mariotti.) Dated March 3.

3106. "Electric and magneto bells and apparatus to be used in connection therewith." H. P. F. JENSEN, J. JENSEN, B. W. WEBB. Dated March 4.

3125. "Apparatus for measuring currents of electricity." S. SUDWORTH. Dated March 5.

3133. "Electrical conductors." W. R. LAKE. (Communicated by H. A. Clark.) Dated March 5. (*Complete.*)

3135. "Electric cables." W. R. LAKE. (Communicated by H. A. Clark.) Dated March 5. (*Complete.*)

3149. "Incandescent electric lamps." A. BERNSTEIN. Dated March 5.

3182. "Cure of liver and stomach complaints through the action of an insulated voltaic electric chain belt." W. LAUGHTON. Dated March 6.

3183. "Dynamo-electric machines." T. A. GARRETT. Dated March 6.

3184. "Prismatic and magnetic compasses." J. H STEWARD. Dated March 6.

3199. "Telephones." J. STUART. (Communicated by G. Hutinet and P. Felix.) Dated March 6.

3235. "Absolutely continuous current dynamo-electric machines." C. J. HALL, W. LAWRIE. Dated March 8.

3240. "Use of electric search light apparatus in an improved way for navigating the Suez Canal and other narrow waters by night." C. HALL. Dated March 8.

3253. "Conversion of electric currents and apparatus therefor." H. H. LAKE. (Communicated by F. Heimel and F. Waldmann.) Dated March 8.

3260. "Current regulating apparatus for use in electric arc lamps, &c." H. H. LAKE. (Communicated by F. Heimel and F. Waldmann.) Dated March 8.

3323. "Electric flash-signalling apparatus." E. S. BRUCE. Dated March 9.

3334. "Electric arc lamps." R. H. COURTENAY. Dated March 9.

3335. "Appliance for preventing overhead broken telegraph and telephone wires from falling and causing injury to life and property, applicable also to clearing the wires of snow." J. M. B. BAKER, H. E. POLLARD. Dated March 9.

3340. "Electric arc lamps." W. H. TRENTHAM. Dated March 9.

CORRESPONDENCE.

Self-Induction.

Every listener present at the discussion which followed Prof. Hughes's most excellent paper must have admired the discourses, in which one professor after another endeavoured to prove mathematically that he knew more about the coefficient of self-induction than the previous speaker. And although, as Lord Rayleigh remarked in opening the discussion, Prof. Hughes meant something else by self-induction than Clerk-Maxwell, and although Prof. Ayrton chided all previous speakers for having lost sight of the main issue of Prof. Hughes's dissertation, yet one and all made the coefficient of self-induction *in a coil* "the burden of their song" (except Prof. Fitzgerald, who, to the satisfaction of everybody present, proved the existence of magnetism before it was born).

Such enthusiasm in the development of the science of electricity is catching, and to assist in the endeavour to make the subject still plainer and easier to understand, I beg to submit for the edification of your readers the following formula for the *coefficient of self-induction in a coil*, as given in Prof. Weidemann's "Electricity," vol. 4, p. 84 :—

$$P = n^2 F\left(\frac{b}{c}\right) = 4\pi a n^2 \left\{ log.\left(\frac{8a}{c}\right) + \frac{1}{12} - \frac{\pi}{3}x - \frac{1}{2} log\,(1+x^2) + \frac{1}{12}\frac{1}{x^2} log\,(1+x^2) + \frac{1}{12}x^2 log\left(1+\frac{1}{x^2}\right) + \frac{2}{3}\left(x-\frac{1}{x}\right) arc\,tg\,x \right\}$$

For very exact determinations the following expression must be added: $n^2 f\left(\frac{b}{c}\right)$, in which is:

$$f\left[\frac{b}{c}=x\right] = \frac{\pi c^2}{24 a}\left\{ \left[log\left(\frac{8a}{c}\right) - \frac{1}{2} log.\,(1+x^2)\right](1+3x^2) + 3{\cdot}45\,(1+x^2) + 27{\cdot}475 - 1{\cdot}6\pi x^3 + 3{\cdot}2 x^3 arc\,tg\,x - \frac{1}{10}\frac{1}{x^2} log\,(1+x^2) - \frac{13}{6}x^4 log\left(1+\frac{1}{x^2}\right)\right\}.$$

This, I think, is very simple, simple enough for any tyro who wishes to find the coefficient of self-induction in the coils of his telegraphic instrument or of the revolving armature of his dynamo; and if not simple enough, he must be a rare simpleton not to be able to use it.

And if it cannot be admitted that this formula is plainer, no one will deny that it is longer (and hence more convincing) than either of those given by the Professors at the meetings, to prove what the President in his paper never attempted to prove, the coefficient of self-induction in

A Coil.

[We consider that our correspondent will earn the gratitude of all seekers after the truth by his contribution to the literature of such an interesting subject. Although the extract to which he refers does not figure in the paper of Prof. Hughes, that is not the fault of Herr Wiedemann. It is a mistake to write in simple language; the author's meaning is apparently less readily grasped and much confusion is the result. —EDS. ELEC. REV.]

American Telephone Patents.

I send to the REVIEW a very important letter bearing on the telephone case, written by an eminent jurist, parts of which may be interesting to your readers.

I have been permitted to read the evidence which was submitted to Secretary Lamar in this case, and I must acknowledge that I failed to find any proof of fraud on the part of Bell or his agents in obtaining his patent of March 7th, 1876, and I hold the opinion that there is no statute which authorises the Government to institute a suit to vacate a patent on any ground that could be pleaded by an individual when sued for infringing that patent; the allegation of fraud in obtaining the patent seems to be one which an infringer cannot plead in defence, but it would seem that the Government must have the right to punish fraud, when committed against it; hence, I infer that the Government can bring a suit to annul a patent on the allegation that it was obtained by fraud, and on that allegation *only*, and on no other. In this case, as it now stands, so far as I can judge of evidence, there is none whatever which proves fraud.

Questions of priority of invention cannot, in my opinion, be tried by a suit brought by the Government. Infringers, when prosecuted, can set up priority of invention. The "hue and cry" against the Bell patent in this country emanates from *would-be* inventors, who have failed to invent a telephone which will work without the use of an undulatory current, or to speak more scientifically, which does not require a *closed circuit;* and the clamour is propagated throughout the land by speculators and owners of shares in speculative companies.

In order to create in the public mind a feeling against the Bell patent, these speculators are continually publishing that Judge Lowell, in his decision in the case against Spencer, June 25th, 1881, decided that Bell's patent covered "the art of transmitting speech by electricity," and, therefore, that no telephone could be made or used in the United States. Now I quote the following from that decision :—

"Bell has the right to hold the broadest claim for it, which can be permitted in any case, not to the abstract rights of sending sounds by telegraph without any regard to means, but to all means and processes which he has invented and claimed."

Mr. Bell certainly was the first to use a *closed circuit* (or undulatory current), and he has a right to it as he claimed it in his patent.

W. C. Barney.

Washington, *February 19th*, 1886.

Secondary Batteries as Regulators.

In reply to Mr. Littleton's query in your last issue as to the cells failing to act as regulators under certain conditions of charge and discharge, I think he will find that this is no abstruse electrical phenomenon, but merely a bad contact somewhere in the accumulator branch. This is borne out by the fact that Mr. Littleton can only get this effect on some nights and not on others.

As it is now an admitted fact that accumulators are by far the most efficient and reliable form of regulator in connection with gas engines or other unsteady sources of power, I should be sorry for your readers to be led to think that there was an electrical condition of balance at which the accumulators failed to steady the light, as in no single installation has this ever been found to be the case, and I think that if Mr. Littleton will go carefully through his connections the phenomenon will disappear.

Bernard Drake, *Managing Engineer.*

Electrical Power Storage Co., Limited,
London, E.C., *March 10th*, 1886.

I am writing in reply to a letter you published from Mr. Littleton.

It is a perfect fallacy to suppose that a secondary battery steadies the E.M.F. in the lamp circuit when the motor is not regular in its speed. The steadying influence only comes into play subject to the various conditions which I placed before the Society of Telegraph Engineers and Electricians in a paper read at their meeting of March 12th, 1885, and enclosed you will find a copy.

Mr. Littleton's data are too scanty to form any opinion as to what is at fault, but whatever the reason may be (if not from bad contacts), it can be found out if this paper is referred to. The probable reason is that the "curve" of the dynamo has some peculiar character not suitable

to the installation, and the resistance of the cells and leads is too high.

Why an accumulator as a rule makes a good regulator is due to the fact that the conditions required to this end usually exist more by accident than intention, for the better the dynamo (from an electrical point of view) the worse is the regulation; and finally, if the machine were perfect the cells would be of no avail whatever for regulation. When the paper referred to was read, I was "called to task" for stating that "a momentary fall in the speed of a pure shunt dynamo causes a rise of E.M.F." It is perfectly true, nevertheless, the rise lasting but a moment; it was, therefore, with great pleasure that I read Prof. Hughes's recent paper on his new discoveries, for they confirm the point which I had observed by making it capable of explanation, and it shows that it is not always safe to ridicule as it may often show ignorance, unless the facts are first investigated. At first sight it might appear that perpetual motion was discovered, but if the sum of all the differences of E.M.F. over a given time are added together, no such new discovery is there. It seems extraordinary to me that so few people are giving real attention to the various relations which exist between dynamo, cells and line, for some statements and also results I have heard and seen are astonishing, and then the results are laid down as a law, whereas in all cases the results have been accidental, and some disappointment will necessarily arise where more efficient dynamos are used, for all the results now put down as law will vanish. The modern dynamos here have proved this long ago, so will common sense if properly applied. I especially refer to the general idea, entertained even by many experts, that the cells act as a regulator under all circumstances, if fairly large, and that the E.M.F. of the dynamo will always accommodate itself to any number of cells, subject only to its being high enough in the first instance to charge the total number in the battery. Both these notions are absolutely wrong, from beginning to end, if the dynamo is a perfect machine electrically, or even approaches this state.

David Salomons.

Broomhill, Tunbridge Wells.

[The paper to which Sir David Salomons refers was published in the REVIEW at the time of its delivery. Sir David apparently contradicts himself in the beginning of the second and fourth paragraphs respectively. —EDS. ELEC. REV.]

Mechanical Telephones.

You have so often used your pages to warn the public against useless investments, would it not be wise to do so again in the case of a new Mechanical Telephone Company, announced in your journal recently; or, if you prefer not, could you inform me how the company is expected to earn dividends from the sale of an article which is in no way superior or cheaper than those offered by many other makers (and have been for years), and which can be beaten in cost of production by private firms easily?

Enquirer.

Theory respecting Faults in Incandescent Lamps.

I have read your article in last week's issue disclosing the opinion of M. Felix Lucas upon the above important subject with very great pleasure, more especially as it coincides to a very great extent with my own views upon the subject. At the same time, permit me to say, that I am afraid no lamp maker will ever be able to produce a more perfect vacuum than that now attained, until our glass manufacturers can devise some means of producing a perfectly non-porous glass; as undoubtedly it is to this cause that the life of so many lamps are shortened, as the vacuum however good it may be, in a newly made lamp, becomes changed when in use by absorption and expansion of the bulbs under different atmospheric conditions; consequently, great care should be taken in the selection and quality of glass used for lamps. Monsieur Lucas appears to have entirely overlooked this latter point, which to my mind is a very important one, and well worthy of scientific research.

In the year 1881 I began to study the defects in incandescent lamps, and noticed that in both the Edison and Swan lamps there was a great tendency of the globes to become blackened after being in use a short time. The Swan more so, owing to the porosity of the glass used, this blackening increasing considerably as time went on. I also discovered in the course of my experiments, that this deposit which is so detrimental to the appearance of the lamps, considerably increases when same are run beyond the actual resistance of the filament and normal C.P. of lamp; when this is done, it causes a gaseous vapour to be thrown off by the action or disintegration of the carbon filament, much more so when these are composed of carbons of a porous nature, prepared of such materials as cotton, silk, cane or vegetable fibres, all of which appear more subvert when extra current is flowing through them. To overcome this difficulty, which is clearly set forth in my patent of 1883, I introduced a carbon filament prepared entirely upon a different mode to that of either Mr. Edison, Mr. Swan or other makers, using as a basis for the new filament, pulverised moss brought into a cellulose state, and saturated with a weak solution of gum, sugar and soot prior to carbonisation; by this mode the filaments are much more dense and less absorbent of the gas used in course of manufacture, consequently purer filaments are obtained, which also give more brilliant light and last longer.

I have been frequently asked by electricians why I adopted the chamber in the neck of the bulb of our lamps; singular to say, I did so amongst other reasons to partly overcome the very defects pointed out by M. Lucas, which fault occurs in nearly all other lamps in the market except those sold by our firm and those of certain makers having a right to use this part of my patent, which is evidently a good point gained, or so many infringements would not have been attempted which in due course will be checked, as it is not my intention to remain passive for ever.

This small chamber in the neck was first introduced by me to act as a receptacle for the gaseous vapour emitted from the filaments, which causes minute infusible molecules of carbonic vapour, which float about in all bulbs of imperfect vacuum, and this gaseous vapour naturally ascends to the highest part of the bulb and deposits itself, first in the receptacle, prior to obscuring the transparency of the entire globe. Thus globes made upon my principle will be found to keep clear much longer than bulbs of ordinary shape used by so many makers.

The present system adopted by us all in manufacturing glow lamps is undoubtedly wrong, both in theory and practice, and certainly the most expensive that could be devised; and in order to meet the future demands of the million for placing cheap lamps in the market, other methods must be resorted to, and something entirely new produced, so as to come within the reach of all, as the demand for lamps is certain to come in due course.

I have always been, as is well known, a believer in low resistance lamps, although others differ from my views; it is, therefore, very pleasing to me to find several makers now following in my steps, by making lamps according to my theory of a volt per C.P.

It may, therefore, interest your readers to know that I have been experimenting for some months past entirely in a different channel, to still further develop the value of glow lamps, and I hope at an early date to be able to place in the hands of electricians a reliable 1,000 hour *low resistance lamp*, which they will be able to sell at about half the present price now charged to the consumer, and with your kind permission, I may have something more to say upon the above subject at a future date.

Arthur Shippey.

13 & 14, King Street, Cheapside, E.C.

[We shall be pleased to learn that Mr. Shippey has succeeded in producing good yet cheap lamps; but one

or two points in his communication lead us to the belief that he is not treading on safe "electrical" ground. Other manufacturers will doubtless form their own opinions on the views above set forth. We presume that Mr. Shippey in speaking of lamps being run beyond the actual *resistance* of the filament, intends to convey the meaning of resistance to rupture. —EDS. ELEC. REV.]

Secondary Batteries.

Will any reader inform me as to the merits of the De Khotinsky cell? Wherein is the difference between the E.P.S. and itself, or any other well-known form? I have heard its efficiency in ampère hours is 90 per cent., provided that the charge and discharge does not exceed a certain ampèrage per pound of lead. What does this pound of lead mean? Is the active, as well as the inactive, to be considered? I should very much like to know where one or more of these cells could be inspected.

R. Mitchell.

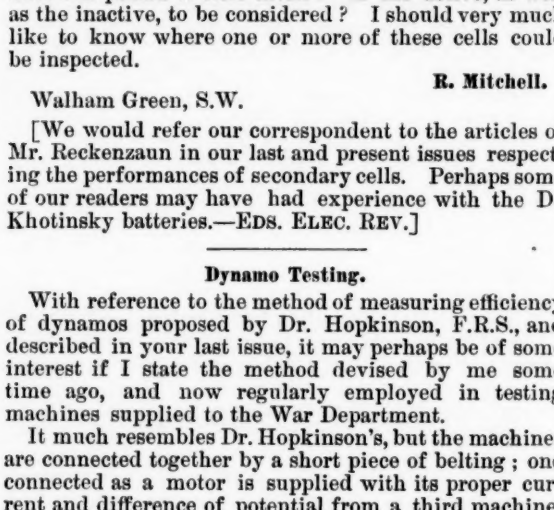
Walham Green, S.W.

[We would refer our correspondent to the articles of Mr. Reckenzaun in our last and present issues respecting the performances of secondary cells. Perhaps some of our readers may have had experience with the De Khotinsky batteries.—EDS. ELEC. REV.]

Dynamo Testing.

With reference to the method of measuring efficiency of dynamos proposed by Dr. Hopkinson, F.R.S., and described in your last issue, it may perhaps be of some interest if I state the method devised by me some time ago, and now regularly employed in testing machines supplied to the War Department.

It much resembles Dr. Hopkinson's, but the machines are connected together by a short piece of belting; one connected as a motor is supplied with its proper current and difference of potential from a third machine, which need not be of similar pattern, but must of course have sufficient power; the other is connected to a variable resistance and generates a current.



The accompanying diagram explains the arrangement, A being the motor and B the generator, R the variable resistance.

The test is as follows:—

The proper volts being supplied to A, R is varied until the current in A equals that specified for the machine. The volts and current given to A are measured simultaneously with the volts at the terminals of B and the current given out by it, when P the power absorbed in A must bear a certain proportion to P^1, that given out by B.

At first, in order not to frighten contractors by this test, P^1 was only required to be $= \frac{P}{3}$.

Even this very moderate requirement, however, caused some uneasiness, and the electricians of a certain well-known company protested that their machines were not designed as motors. However, when they tried it, and found that they easily exceeded the requirement, they ceased to asperse their machines, and, indeed, have since discovered that these same machines are exceptionally efficient motors.

The advantage of the test is, that no measurements except electrical ones are required, and if the instruments used are at all doubtful the same instruments may be used for the two circuits, alternating them by means of switches.

I was led to adopt it by the doubts I have always felt of dynamometer measurements, which are perhaps all very well for one's own amusement and edification, but would certainly lead to difficulty between two parties interested in the result. The unsettled condition of the electrical units, and of the calibration of instruments, also decided me to adopt a method which is quite independent of the absolute value of the volt and ampère, or of the markings on an instrument, so long as it is fairly consistent with itself.

I do not find any objection to the test now on the part of contractors, although I have raised the efficiency required.

I hope when occasion serves to extend this method of measuring the power absorbed by a motor to exactly measure the power lost in countershafting, long belts, &c., which should, I think, give valuable results.

Dr. Hopkinson's arrangement is certainly most ingenious and complete, but as the loss is measured on a mechanical dynamometer, it would hardly, I think, answer the same purpose as my test.

P. Cardew, *Capt. R.E.*

Chatham, *March*, 1886.

In the measurements of the efficiency of dynamos by Dr. Hopkinson's ingenious method, would it not be possible to carry out the principle more fully, so as to dispense with *all* measurement of mechanical power, by introducing into the circuit a few storage cells which should supply the small percentage of energy wasted. In this way all the data could be observed electrically.

Rayleigh.

Athenæum Club, Pall Mall, S.W.,
March 9th.

The FitzGerald Secondary Battery.

It would appear, from the note on p. 215 in your last issue, that M. Hospitalier accuses me of making use of his name, and of doing so in an unjustifiable manner. I have written to demand that he shall at once retract this allegation or inform me of the grounds on which it is made. Until I receive his answer I shall forbear from characterising his conduct in this matter.

In the meantime, I think there is little danger that those who know me—and who know of my position in relation to the commercial working of my inventions—should think me capable of making the statements complained of. These—which might be merely mistakes on the part of others—would in my case involve direct (and very foolish) falsehood, since I happen to be aware that, for reasons best known to himself, M. Hospitalier has kept back his expected report on the results of his experiments with my battery, and since these results are well known to many persons besides myself, M. Hospitalier, I think, considerably overrates my estimate of his importance in relation to the battery, which latter—more especially in its improved form—will be well able to speak for itself when it gets into other hands.

Desmond G. FitzGerald.

Charge and Discharge Indicators for Secondary Batteries.

As secondary batteries are now attracting the serious attention which might long since have been well bestowed upon them, consideration is naturally being given to the various devices which, under extended conditions of employment, become essential for their regulation and control.

Notice has lately been especially directed to the necessity of having at hand some simple method for

arriving at their state of charge and discharge, and for automatically cutting in or out of circuit at the proper time.

I need hardly say that these are some of the several details essential to their satisfactory working to which I long since gave my attention; and as the question has now been publicly mooted, it may be useful to those of your readers who are interested in this subject to be informed that one of my patents, No. 1644, 2nd April, 1883, deals specifically with these points—anticipating the ideas set forth in Mr. Parker's specification, dated 8th August, 1884, of which a full description is given in your last issue.

Certainty of action, together with the utmost simplicity, are desirable in any devices employed for such purposes; and I venture to think that nothing can be more simple, nor (as I have proved by long experiment) more reliable than the means I have described.

With reference to the space in the cell necessary for any such contrivance, an inch at one end is all that is wanted; and this is, or should be, a normal condition, there being advantages in having ample sufficiency of the electrolyte, as also room for its free circulation.

For the proper working of the arrangement described by me, due precaution must, of course, be taken to ensure equal diffusion of the electrolyte; but this is essential under any and all circumstances, *and must on no account be neglected.* The natural gravitation of the sulphuric acid, as it is discharged from the plates, will quickly cause a difference in density between the top and bottom of the cell of 10, 15, or even 20 degrees, bringing about other evils, such as unequal resistance in the different parts of the cell, and consequent uneven work on the plates. Of the two ready methods for avoiding this, the one to be preferred is the employment of a common India rubber valve hand ball, with a tube of glass or vulcanite attached to it for plunging into the cell, with which the liquor can be quickly "blown up" twice or thrice a week; a work, say, of five minutes for every 20 cells. The other method is to overcharge every other day before stopping for two or three minutes, by which the electrolyte is agitated and to some extent mixed.

I need hardly say, however, that much or continuous overcharging is to be deprecated, not only on account of the waste of energy, but because a minute disintegration of the peroxide plate takes place; the fine mud thus formed and deposited tending, in course of time, to bring about contacts, besides, of course, gradually lessening the amount of active material in the plate. The "blowing" process, which I have always employed, has further the advantage of preventing any accumulation of deposit upon the separating plugs of the plates; a result of much overcharging or of too rapid discharge.

I would observe that by adopting the above-described simple method, I have experienced no difficulty whatever in regulating my accumulators; and having once given my gardener instructions to charge until the acidometer has risen to a certain mark on the scale (in my case 1,220°) I have no further occasion, from month's end to month's end, to give any thought or attention to the matter.

John S. Sellon.

Sydenham Hall, *March 8th*, 1886.

I enclose a copy specification—*vide* lines 7 to 30, folio 3, and 7 to 15, folio 5.

My invention has for its object the effecting the cutting out of or putting into the charging circuit of secondary batteries, commonly called electrical accumulators, by means of the motion imparted to an acidometer, or other equivalent instrument or appliance, such, for instance, as a float or ball, or a vacuum box, which can be made to rise or fall or be actuated in accordance with the variation in strength, density, or specific gravity (during charging or discharging) of the electrolyte or fluid employed in such batteries.

The motion thus imparted to such acidometer, float, or equivalent instrument (which may be suitably constructed either of metal or of glass, or other material with metallic attachments or conductors to cause contacts) actuates mechanical or electrical devices, or a combination of the same, or it may act simply by pressure upon a lever, shunt, valve, or equivalent mechanism, so that the electrical current is shunted off from or on to the cell or cells thus influenced, and by this means each cell to which such arrangement is attached, or each set or sets of cells in connection therewith, which can or may be so controlled thereby, can be cut out of circuit of the charging or main circuit, and can be made to fall in again as required.

For example, one simple arrangement for attaining this end is the employment of a platinum or other suitably-constructed float situated in or on the solution, and making or breaking contact with the rise and fall of the density of the solution. By the rise and fall of the said float or contrivance, as the density of the solution varies, contacts can be made, and by such contacts, through the medium of a relay or other device, sufficient power may be given to work a switch or suitable mechanical or electrical contrivance by which the main charging or the discharging current may be cut in or out as desired.

My invention can be also utilised for the purpose of indicating, by the rise and fall of the acidometer, float, or instrument, the condition of the batteries at any time, that is to say, either the extent to which they have been charged, or the amount of electrical energy remaining in them.

My invention can also be utilised for indicating and registering the amount of current put in or taken out of the cells or batteries, each contact made by the rise and fall of the float or instrument at the time of charging or discharging actuating by mechanism a ratchet wheel, or other suitable device, which sets in motion the necessary mechanism.

It would appear, from remarks lately published on the above subject, that the existence of a practical guide as to the condition of secondary batteries is not generally known.

Now that the working of secondary batteries is beginning to be better understood, the necessity of a reliable indicator and current manipulator is recognised, not only for isolated installations in order to prolong the life of the plates, but also in distributing electrical energy over wide areas.

Having had some experience with an arrangement which depends upon the rise and fall of the specific gravity of the electrolyte, I enclose rough sketches of same, feeling sure it would interest many to know what has been done in this direction.

Figs. 1 and 2 illustrate an indicator; this form I have found very useful for showing the condition and quantity of current put in and taken out of cells.

An acidometer or hydrometer made of platinum or glass is in the electrolyte, attached to this is a wire of glass or platinum, to which is joined a silk thread; this silk thread passes over a grooved wheel, ending with a cup or weight, which is weighted to the desired degree; this arrangement is similar to the action of a wheel barometer.

Under ordinary conditions of working, ten degrees of density may be taken as representing 100 ampère hours, which gives considerable motion to the bath or float. It is obvious that the grooved wheel can be made of such a size as to give large or small readings.

Figs 3 and 4 show an automatic current manipulator or charging switch, whereby any number of sets of cells may be brought in or cut out of the charging circuit by the rise and fall of the density of the electrolyte. . . . . .

It will be seen that by such an arrangement sets of accumulators can be readily and surely switched in and out of the charging circuit at any desired point of charge or discharge.

The durability of secondary batteries depends upon this being done at the proper time.

The above arrangements are the invention of Mr. Sellon, patents for which were taken out by him in April, 1883, or nearly three years since.

Henry A. Kent.

[As the drawings 1 and 2 do not appear to us to be necessary to render the explanation of the indicator clear, we omit them; and the remainder of Mr. Kent's letter being entirely devoted to a description of Mr. Sellon's apparatus, to which that gentleman himself refers, we do not think it necessary to re-produce that which can be found by those interested, in specification No. 1,644, 2nd April, 1883.—EDS. ELEC. REV.]

Telephone Patents.

I note the remarks of your correspondent "Combination," *re* the Valve telephone. His experience appears to have been unfortunate, and he has apparently jumped to the conclusion that the failure to make the New Telephone Company's instruments work satisfactorily, was due to there being no diaphragm in the transmitter. Our experience with the same company's instruments has not been very fortunate, but we put the result down to bad workmanship in the manufacture.

Some months back, the New Telephone Company placed a pair of their complete sets—transmitter, two receivers and call bell—at our disposal for trial.

They were only tried upon a short line, but the articulation was certainly remarkably good, in my opinion far superior to that of the Bell telephone. There was no Punch and Judy talk, nor was there any of the disagreeable jarring or buzzing that one finds with other instruments at times. The one fault appeared to be, a deficiency in the volume of the sound—in the loudness.

Where the instruments broke down in our hands was:—First, we required to work three stations on one line. As every one knows, there is no difficulty with the ordinary arrangement, in working as many as you please; but with the New Telephone Company's instruments, the whole of the battery being to line, when two stations were speaking, the third was ringing, and causing a continuous clatter in the receivers.

As we were rather busy at the time, we applied to the company to know if they had worked out any plan of overcoming this, to save us the trouble of doing so ourselves, as I have no doubt we could have done with a little thought. In response to this apparently, an inspector was sent down, who appears to have changed the character of the microphone altogether, and we never succeeded in getting the arrangement to speak properly afterwards.

The arrangement which we tried, and which spoke well, consisted—the microphone—of a polished carbon ball, resting lightly on three platinum points, and protected by an inverted footless wineglass. My own opinion is, that the instrument is a good one, but that it requires to be well made, and, perhaps, some small alteration of details, and that its faults are such as time and experience will overcome.

Sydney F. Walker.

In your issue of March 6th, we notice a communication signed "Combination," in which he says he has failed to get the Valve telephone to work. We have pleasure in stating that we bought a complete set of instruments from the New Telephone Company, Limited, having previously run the line. We had the instruments working in one and half hour's time after receiving them, never having seen a pair before, the party we fixed them for being highly satisfied with them. They had previously had a pair of Bell-Blakes from the United Telephone Company.

Anyone requiring a pair fixed in the North of England, we will put them a pair in a week on trial, and if not satisfactory, will take them out free of charge.

Jno. Barrett & Bros.

Yorkshire Street, Burnley.
March 6th, 1886.

Referring to the letter of "Combination" in your issue of 5th inst., allow me to point out that the highly imaginative allegations of your correspondent are best answered by a reference to the testimonials which appear in your advertising columns.

J. W. Barnard, *Secretary.*

New Telephone Company, Limited,
4, Great Winchester Street,
London, E.C. *March 8th*, 1886.

In his letter of February 15th, "Combination" appears to lay the entire blame of the inefficiency of the New Company's instruments on the "Valve" transmitter.

Some of your readers will perhaps remember a controversy that took place in your pages some months ago between Mr. Barnard and myself concerning the membrane receiver of the same company, when I expressed my doubts as to the efficiency of that instrument both on account of the nature of the membrane arrangement and also the wonderful "plug" device employed to assist the magnetising of the electromagnets, and I cannot now help thinking that the bad results of which "Combination" complains are largely due to the receiving apparatus used.

As regards the "Telephone Conference" proposed by Mr. W. E. Irish, I am unable to discover what possible good such an arrangement could do beyond benefiting the hotel keepers of "London or Paris" and the railway companies leading thereto, as all the telephone conferences in the world cannot alter the patent laws of the country, or, what is, perhaps, more to the point, limit the meaning of that wonderfully flexible and elastic word "diaphragm" as employed in Edison's specification. I notice, however, that one of the objects of the proposed conference is "to investigate claims," and taking these significant words in conjunction with the fact that *a* Mr. W. E. Irish (and I am not aware that there are two telephonic electricians of that name) is the patentee of certain telephones claimed by the inventor as free from the Edison and Bell patents, it is not, perhaps, very difficult to imagine whose claims in particular the conference is to investigate.

In plain language, perhaps Mr. Irish is anxious to float an association to run his patents and imagines that a "conference" would be an inexpensive way of starting the same.

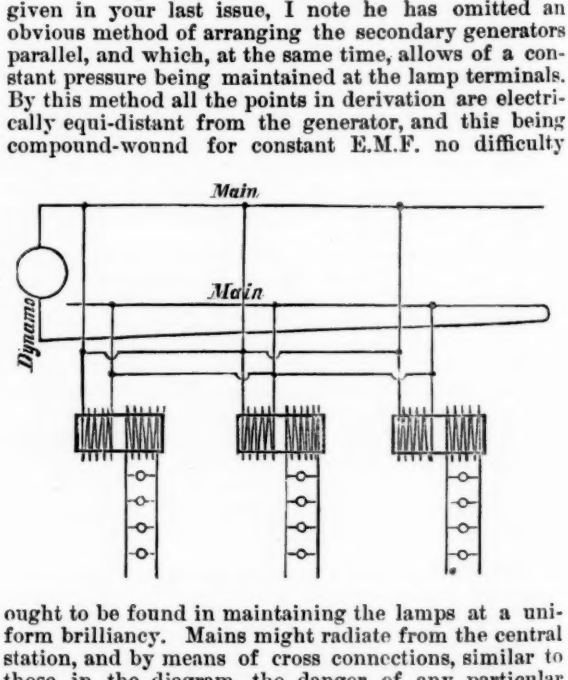
I hope he will contradict me if I am wrong.

"Telephonist."

March 9th, 1886.

The Distribution of Electricity.

In looking over Prof. Forbes's interesting paper, given in your last issue, I note he has omitted an obvious method of arranging the secondary generators parallel, and which, at the same time, allows of a constant pressure being maintained at the lamp terminals. By this method all the points in derivation are electrically equi-distant from the generator, and this being compound-wound for constant E.M.F. no difficulty



ought to be found in maintaining the lamps at a uniform brilliancy. Mains might radiate from the central station, and by means of cross connections, similar to those in the diagram, the danger of any particular district suddenly being left in the dark could be greatly minimised.

I hope to see the matter of distribution by means of secondary generators well ventilated in your columns.

R. C. Jackson.

March 2nd, 1886.